

Stream Inventory Handbook

Level I & II



Region 6
1993 ~ Version 7.0

Stream Inventory Handbook

Version 7.0

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CHAPTER 1

Stream Inventory Handbook

100.0 Introduction/Overview

110.0 Introduction

120.0 Manual Overview

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110.0 Introduction

BACKGROUND: Periodic, recurring inventories are an integral part of the fish habitat and watershed management programs and form the foundation for effective program management. They should produce comparable information, both between administrative units, as well as across time. They will generate the baseline information that will be used to support a variety of management activities, including, but not limited to; timber sales, range allotments, special use development and fish habitat and watershed restoration programs. They will also serve as the basis for stream monitoring and evaluation programs. Specifically, inventories will identify existing aquatic and riparian conditions, identify factors limiting the productive capabilities of habitats, measure attainment of meeting stream habitat objectives, and help to assess cumulative watershed effects. The inventories can be used to monitor and refine Land Management Plan Standards and Guidelines.

The purpose of this inventory is to identify existing riparian and aquatic ecosystem conditions on a basin-wide scale. As inventories are completed and repeated over a number of years, the information generated by them will be particularly useful in measuring attainment of the habitat objectives defined for the stream system. In this context, the inventory will be applied as a basic "monitoring" tool.

INVENTORY ATTRIBUTES: Key attributes of the Region 6 Level 1 and 2 stream inventory include:

Driven by questions that are to be addressed. Identification of management questions formed the basis for the content of the inventory. The ability to address questions consistently and comparably across units has been demanded of the USFS by both users and managers of the resources. Inventory and analysis procedures were developed to provide the information necessary to answer those questions..

Contains a consistently applied set of core attributes. The Level 1 and 2 inventory contains data attributes that were identified by a USFS interdisciplinary team as being the most critical in defining aquatic resource condition. The survey is attribute driven, rather than driven by classification systems. It was acknowledged that classification systems can change over time, while attribute data remains constant. Information collected can be related to a number of classification systems, if the user determines that the classification system plays an important role in analyzing and interpreting the data.

Quantification in nature. Where practicable, the inventory generates quantitative estimates of habitat attributes. There are some attributes such as cover that are difficult to describe in quantitative terms. Where these occur, categories or classes are used to qualify the attributes (e.g., canopy cover, class 1 = 0-25 percent class, 2 = 25-50 percent, etc.).

Statistically valid approach. The inventory meets assumptions for standard statistical analysis and results in estimates with known bounds of error.

Repeatable. Documentation of a standardized protocol and ability to segregate and evaluate surveyor bias support consistency in the replication of survey efforts, both across time and administrative boundaries.

Coordinated with other resource areas and management entities. This survey represents an integrated approach between USFS watershed and fisheries disciplines in defining aquatic resource conditions. It has been reviewed and is compatible with similar stream inventories developed by state agencies, specifically the Oregon Department of Fish and Wildlife and Timber, Fish and Wildlife in Washington State. This survey, as with these others, does not include information at a

high enough resolution to address all management information needs for a number of other resource areas, such as range, wildlife, or soils.

Integration of the stream inventory with the USFS Integrated Resource Inventory (IRI) is underway. The IRI currently does not address the aquatic components of a basin. It has been recognized that this stream survey protocol, with minor modification will provide the information needs currently lacking in the IRI. Full integration should occur by 1994.

Cost efficient. Following 4 years of operational testing, the average cost to complete this survey is \$750 dollars per mile. Local conditions such as stream size, channel complexity, location, etc. contribute to a range of costs from less than \$350 dollars to more than \$900 dollars per mile. These estimates include data collection, data entry, analysis and report writing.

ESTABLISHING FOREST PRIORITIES

The stream inventory program should become an institutionalized component of the fisheries and watershed programs. As such, a realistic rate of inventory should be identified in these program areas. The "Rise to the Future" Action Plan recommends a survey rate of 10 percent of fish bearing streams per year. This infers a 10 year recurrence interval for all fish bearing streams.

Forests should consider the following factors in setting priorities for stream inventory:

- * Sensitivity of fish stocks present.
- * Habitat/watershed vulnerability or sensitivity; watersheds that are particularly vulnerable or sensitive to management activities should be a high priority.
- * Level of planned activity in the watershed.
- * Management plan development (Wild and Scenic Rivers) or agency coordination/cooperation.
- * Relative importance of watershed in terms of fish production or use.
- * "Representativeness" of watershed to others for stratification and extrapolation of information to those systems that are lower priority.
- * Size/feasibility of detecting change and managing that change (it is more difficult to detect change in larger systems and frequently more difficult to mitigate those effects).
- * Wilderness or watersheds representing intact, hydrologically functioning systems; to be used in developing numeric ranges for Desired Future Conditions variables.

STREAM INVENTORY PROGRAM MANAGEMENT

Data Management: The SMART database program was developed as an ORACLE application on the Data General system to facilitate the sharing of information between units and to support Regional efforts to integrate Level II inventory information into the GIS environment. Three different methods can be used to input data into the SMART database: the DG SMART program; the SMART program using PC ORACLE; and importing an ASCII file through the walkabout Load subroutine. Regardless of which method is used to input data, all Level II stream inventory data will be stored within the corporate DG SMART database.

A series of standard summary tables have been developed within the SMART program. The tables provide the basic information necessary to characterize stream condition, habitat, and function. Forests and Districts are encouraged to do additional data analysis to explore specific habitat relationships and develop more effective ways of presenting the information. Additional analysis can be done most efficiently by downloading the stream inventory data into a PC environment.

PRESENTATION OF INFORMATION

A suggested report format for summarizing and presenting stream inventory data is presented in the manual. It contains two basic components which provide information in a legible, understandable format to two distinct audiences: Line and Staff, and the Technical Specialist.

The executive summary highlights the condition and identifies the issues, concerns and opportunities within the watershed for line and staff. The main body of the report is geared more toward the technical specialist. It contains summaries of the quantitative data collected as well as field observations and the resulting conclusions on stream condition, habitat interrelationships, and potential factors limiting fish production. The information is summarized at both the reach scale and the basin scale.

The foundation for every report resides in sound interpretation of the available inventory information. Rather than merely a regurgitation of numbers and figures in the summary tables, interpretation should begin investigating the inter-relationships that exist between the data attributes. For example, width:depth ratios relative to residual pool volumes, and bank substrate. Correlations of pools per mile to riparian vegetation composition and amount of large woody debris can aid in identifying potential habitat deficiencies in systems as well as give an indication of potential rehabilitation potential.

Although basic data interpretation can be completed by the individuals conducting the stream survey, all reports should have journey level fish biologist or hydrologist review and concurrence. The management applications section of the report should be written by the journey level professionals. A full understanding of the inter-relationships of the fisheries and hydrology programs will result in the development of sound, realistic management recommendations.

120.0 Survey Manual Overview

CONTENT

The Stream Inventory Handbook provides instruction for conducting the Level 1 and Level 2 stream survey. It contains five primary sections: Procedures manual, Report Format, Appendices, Forms, and Miscellaneous Notes.

A software User's Guide for the SMART database will be issued as a separate document. It is available to Forests following completion of DG SMART training.

Procedures Manual: This contains the specific instructions for conducting both the office and field surveys. Information collected from the office phase is placed on the A and B1 forms. The B1 form serves as a preliminary guide for initial reach delineation. It will be discarded following ground verification of reach stratification. The field phase utilizes forms B2, C, C1, C2, and C3 which contain information on the physical attributes of the stream, and form D which documents fisheries information.

Report Format: This section contains a suggested report writing format to follow in developing the final stream survey reports. Instructions for each subject area are provided.

Appendices: The appendices contain specific information that support a number of the data attributes collected in both the office and field phases.

Forms: There are a total of 8 forms that are completed as part of the survey. These clean copies are provided as masters from which to make your working copies. **Please note:** Waterproof, smudge-proof forms can be developed by using opaque transparencies as the base medium. These are relatively inexpensive, and can be mass produced on any Xerox machine.

Miscellaneous Notes: Included are specific information items that require forest level decisions or interpretations, and a list of updates to previous manuals.

CHAPTER 2

Stream Inventory Handbook

200 LEVEL I - IDENTIFICATION LEVEL - OFFICE PROCEDURE

- 210.1 Objectives
- 210.2 Standards
- 210.3 Equipment Needed
- 210.4 Procedure

STREAM INVENTORY HANDBOOK

200 LEVEL I - IDENTIFICATION LEVEL - OFFICE PROCEDURE

210.1 - Objectives. The objective of the office phase is to provide the field crews with a general introduction to the stream system targeted for survey. This is accomplished through assembly and summarization of any data that has been previously collected for the basin. This information will be used to tentatively stratify the stream system into stream order and stream reach. A reach is a relatively homogeneous section of stream that contains attributes of common character. Review of the information compiled by the office phase will be extremely valuable in selecting sampling intervals using Hankin/Reeves methods, planning stream access logistics, summarizing initial hydrologic information, and initially identifying perennial and fish-bearing streams.

Aerial photo analysis and use of maps of suitable scale e.g. 1:24,000 will enable the survey team to identify with some accuracy such attributes as: sinuosity, vegetative types in riparian and upslope areas, watershed acres, valley bottom widths, tributary confluences, and watershed characteristics. The maps created during this process will be of great value to the field crews who survey the watershed more intensively at a later date. An effective field map(s) will show tributary streams, road crossings, access points, and general location of notable geologic features, and unique characteristics. These parameters will be used by the field crew to accurately locate reach breaks and features in the basin.

210.2 - Standards. The office phase survey will provide information only as accurate as the scale and accuracy of the maps, photos and previously collected data. Accuracy will also be affected by the human error introduced when measuring the attributes required. At a minimum, use 1:24,000 scale USGS topographic maps. Any measurements should be confirmed with a map wheel, dot grid, or other standard method of measurement.

210.3 - Equipment Needed.

- Topographic Maps/Aerial Photos—Scale of 4 inch to the mile preferred.
- Planimeter/Map Wheel
- Calculator
- Watershed Codes from FSH 2509.24
- Hydrological Data—flow, temperature, turbidity, stream class, macroinvertebrate, etc.
- Geological Information—Geological province, landform type, etc.
- Past Stream Surveys—Measured length of reaches, pool/riffle/glide ratios, etc.
- Level I - Office Phase Form
 - Form A - Stream Identification Form
 - Form B1 - Preliminary Reach Identification Form
- Canopy cover template

210.4 - *Procedure*. The office phase requires the completion of Forms A and B1. Much of information for Form B1 can be collected from the aerial photos and topographic maps. Each set of form instructions have an "Attribute" and "Measurement/Recording" section. The "Attribute" describes the parameter evaluated, while the "Measurement/Recording" section provides instruction on how to collect the attribute information. At the end of each discussion, a character or numeric field length is given. **PLEASE NOTE THAT THE INSTRUCTIONS FOR COMPLETING THE HEADER FOR EACH FORM ARE LISTED IN FORM 'A' INSTRUCTIONS. ATTRIBUTES A THROUGH H ARE THE SAME FOR EACH FORM.** Where additional header information is required, specific instructions are given for that form.

STREAM IDENTIFICATION - FORM A, R6-2500/2600-10.

Fill out a Form A for each stream:

Form A Instructions

ATTRIBUTE

MEASUREMENTS/RECORDING

A. State

Enter the appropriate 2 letter code:

Oregon OR
Washington WA
California CA
(FL:2 (e.g., ZZ))

B. County

Uses FS-ATLAS national standard (FL:3 (e.g., 999))

C. Forest

Enter appropriate two digit code for the Forest. (FL:2 (e.g., 99))

D. District

Enter appropriate two digit code for District. (FL:2 (e.g., 99))

E. Stream Name

Enter name of stream as shown on USGS quad limiting the length of the name to 40 characters. (FL:40)

F. Watershed Code

Refer to FSH 2509.24 to determine to correct Hydrologic Unit Code for the watershed. Enter only the first four 2 digit fields (Hydrologic Region, Hydrologic Subregion, Accounting Unit, and Cataloging Unit).
Refer to Appendix A for a more detailed explanation.
(FL:8 (e.g., 99,99,99,99))

NFS Code

Refer to FSH 2509.24 to determine the correct NFS Watershed Number (2 digits) and NFS Subwatershed code (1 letter) for the stream to be surveyed.
(FL:3 (e.g., 99,A))

If the stream to be surveyed does not begin at the mouth of the NFS Subwatershed, enter the measured map stream miles from the mouth of the mainstem which forms the NFS Subwatershed to the confluence where the surveyed stream joins. Up to four mileage entries can be used to identify the specific stream, if necessary. See Appendix A for a more detailed explanation on how to determine the stream mileage identifiers.
(FL:4 (e.g., 99.99, 99.99, 99.99, 99.99))

G. USGS Quad

Enter the name of the registered USGS 1/2 Quad containing the stream mouth or point where it leaves the Forest. This is the 1:15,840 or 4 inch to the mile map base used in TRI. (FL:60)

H. Survey Date

Enter the date the field survey began using the following format:
DD-MMM-YY (ie., 01-Jun-91).

Form A Instructions (continued)

- | | |
|---------------------------------|--|
| 1. Name | Person filling out Form A; follow DG format (J.Smith). <i>NOTE:</i> This parameter <i>will not</i> be entered into the computer Form A. |
| 1. Watershed Area | Calculate the area of the basin above the mouth or above the point where the stream leaves the Forest to the nearest 250 acres. This measurement may be easier to attain using a map scale of 1" = 1 mile. (FL:6 (e.g., 999,999)) |
| 2. Stream Order | Utilizing the Strahler method (Appendix B), identify stream order. A 1st order stream is the smallest fingertip intermittent tributary. (FL:1 (e.g., 9)) |
| 3. Stream Class | Designate the stream class of the stream(s) to be surveyed (e.g. Class 1, 2, 3, 4. See FSM 2526 or TRI Aquatic subsystem. Note: The SMART program will not accept Roman numerals for stream class designations at this time. Numeric codes must be used.) If not available, leave blank. (FL:1) |
| 4. Fish Species and Data Source | Starting from the left, record dominant or management emphasis fish species known to be in the basin. See Appendix C for species abbreviations. If no data exist, write "Nothing on record." <i>NOTE:</i> This field is 240 characters long (Memo FL = 240). |
| 5. Flow Data | Enter in narrative form, the availability of flow data. List all sources, such as USGS gauging stations, Forest monitoring sites, IFIM studies, etc., and dates data were collected. If no data exist, write "Nothing on record." <i>NOTE:</i> This field is 240 characters long (Memo FL = 240). |
| 6. Water Quality Data | Review files for any quantitative physical or chemical data. Reference the type and source of information, and year data were collected. If no data exist, write "Nothing on record." <i>NOTE:</i> This field is 240 characters long (Memo FL = 240). |
| 7. Macroinvertebrate Data | Enter, in narrative form, the type and source of information. Examples include analysis conducted by the Aquatic Ecosystem Analysis Lab, local forest studies, etc. If no data exist, write "Nothing on record." <i>NOTE:</i> This field is 240 characters long (Memo FL = 240). |
| 8. Previous Surveys | Reference the source of the information, level of survey and year accomplished. If no data exist, write "Nothing on record." <i>NOTE:</i> This field is 240 characters long (Memo FL = 240). |
| 9. Historical Land Use Data | Record here any useful historical information you may have regarding the stream (e.g. old photos, interviews on file, splash dams, mining, literature, etc.). Also review the Forest's Historical Land Use Atlas – see an Archeologist for this document. If no data exist, write "Nothing on record." <i>NOTE:</i> This field is 240 characters long (Memo FL = 240). |

Form A Instructions (continued)

10. Coordination

Verify participation or coordination with other agencies or interest groups. Explain group and their work to be accomplished (Memo FL = 240).

11. Comments

Use this space to elaborate on the above attributes. Note apparent watershed problems, special features or habitats, fish stocking information, management problems, studies, critical habitats, special land allocations, etc. (Memo FL = 240).

Page: 1 of 1

A. State OR B. County 03 C. Forest 12 D. District 03
E. Stream Name: Example Creek
F. Watershed Code 17, 10, 02, 05 NFS 28, H; , , ,
G. USGS Quad: Tide water
H. Survey Date: 92 / Aug / 28
 Year / Month / Day
I. Name: R Metzger

- ODFW Index Stream - Coho

Data Source: Nothing on Record

Data Source: Nothing on Record

Data Source: Nothing on Record

Data Source: 1978 Stream Survey - USFS

Data Source: RM 0.0 - 0.5 Old Homestead
RM 1.5 - 2.0 Private Commercial Timberland

11. Comments: Stacked annually with coho and
1 winter steel head

PRELIMINARY REACH IDENTIFICATION - FORM B1, R6-2500/2600-20

Form B1 is used to break the stream system into *preliminary* homogeneous stream reaches necessary for selecting sampling intervals and summarizing, interpreting, and reporting information. Reach characteristics which should be used to initially select stream reach breaks are: valley form and valley width, relative gradient changes, channel form changes, stream order (tributary confluences), sinuosity, and flow changes.

The field crew will verify the initial reach breaks and locate them accurately on a field map/photo.

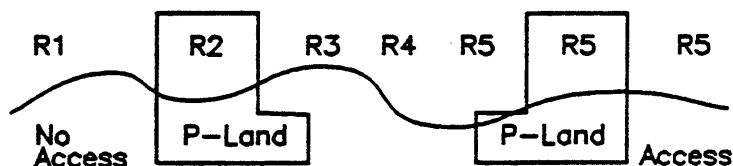
Actual delineation of final reach breaks will occur during the on-the-ground survey. When the field portion of the survey is complete, the information from Form B1 will be used to complete Form B2; once Form B2 has been completed, Form B1 is no longer needed. *NOTE: Form B1 data will not be entered into the data base.*

Fill out a Form B1 for each stream reach:

(NOTE: INSTRUCTIONS FOR ATTRIBUTES A - H ARE LISTED ON THE FORM A INSTRUCTIONS)

Form B1 Instructions

- 1. Reach Number and River Mile** Enter the reach number beginning at the lowest point of the proposed survey, number the reaches sequentially upstream. Enter river mile as it corresponds to the starting and ending points of the reach to the nearest 0.1 miles. The ending river mile of the lower reach is the beginning river mile of the adjacent, upstream reach, (eg., Reach 1, RM 0-1.1; Reach 2, RM 1.1-4.0; Reach 3, RM 4.0-5.2). Use designated EPA river reach miles if available; if not, begin the mileage mark at the mouth of the stream, starting with RM-0. If starting at the mouth is not possible the beginning RM should reflect this distance (eg. survey starts 5 miles from mouth then the beginning river mile should be RM = 5.0) **NOTE ON REACH NUMBERING:** Private land inholdings—If access is denied, treat the private land section as a separate reach. See diagram below. If access is available, do not break out as a separate reach. Use standard geomorphic characteristics as described above.



Form B1 Instructions (Continued)

2. Valley Form Enter appropriate code (1-10) that best describes the valley form. Examples are: Wide, glaciated U shaped Valley; Steep, narrow V shaped valley; Broad, flat plain; Alluvial outwash; etc. (See Appendix D).
3. Valley Width Class Enter the code which best describes the valley floor width. See Appendix D for illustrations.
1= <100 feet
2= 100-300 ft.
3= 300-600 ft.
4= >600 ft.
4. Flow Regime Changes Note any large tributaries that originate in watersheds of large or similar size to the proposed surveyed watershed. Reaches can be stratified by significant changes in flow, while other variables remain the same. Enter yes Y or no N if this is used for reach delineation purposes.
5. Sinuosity Check the appropriate code for each reach using topographic maps.
6. Average Reach Gradient Use GROSS changes in gradient to develop preliminary channel reach breaks. Long homogeneous lengths of similar gradient may delineate a reach. However, other parameters can temper the stratification. For form B1, gradient will be calculated by dividing the elevation gain (high elevation contour minus low elevation contour) by the lineal distance of stream, for each reach.
7. Stream Canopy Closure Circle the code for percent of the stream canopy closure created by any source (vegetation, topography, etc.) in the following categories:

1. 0 - 19%
2. 20 - 30 %
3. 31 - 60%
4. > 60%
- This may be determined *either* in the office from canopy cover templates on aerial photo *and/or* paired aerial photographs under a stereoscope.
8. Other Note any other criteria that you used to help make the reach stratification.
9. General Comments Write down any comments important to the aquatic/ riparian resources. This is a good place to clarify some of the entries made above.

A. State OR B. County 03 C. Forest 12 D. District 03
E. Stream Name: Example Creek
F. Watershed Code 17, 10, 02, 05 NFS 28, H; , , ,
G. USGS Quad: Tidewater
H. Survey Date: 92 / Aug / 28
Year/ Month /Day

1. Reach # 1 RM 0.0 to 0.5
2. Valley Form 9
3. Valley Width Class 1 2 3 4
4. Flow Regime Change N
5. Sinuosity H M X L S
6. Average Reach Gradient 0.5 %
7. Stream Canopy Closure 1 2 3 4
8. Other

9. General Comments: Begin at confluence with
Alsea River

1. Reach # 2 RM 0.5 to 1.5
2. Valley Form 8
3. Valley Width Class 1 2 3 4
4. Flow Regime Change N
5. Sinuosity H M L X S
6. Average Reach Gradient 2.0 %
7. Stream Canopy Closure 1 2 3 4
8. Other

9. General Comments:

1. Reach # 3 RM 1.5 to 2.0
2. Valley Form 8
3. Valley Width Class 1 2 3 4
4. Flow Regime Change N
5. Sinuosity H M L X S
6. Average Reach Gradient 2.0 %
7. Stream Canopy Closure 1 2 3 4
8. Other

9. General Comments: Private land - not surveyed

1. Reach # 4 RM 2.0 to 3.0
2. Valley Form 2
3. Valley Width Class 1 2 3 4
4. Flow Regime Change N
5. Sinuosity H M L X S
6. Average Reach Gradient 8.0 %
7. Stream Canopy Closure 1 2 3 4
8. Other

9. General Comments: End at Slippery Rock
Falls - anadromous barrier

1. Reach # RM to
2. Valley Form
3. Valley Width Class 1 2 3 4
4. Flow Regime Change
5. Sinuosity H M L S
6. Average Reach Gradient
7. Stream Canopy Closure 1 2 3 4
8. Other

9. General Comments:

1. Reach # RM to
2. Valley Form
3. Valley Width Class 1 2 3 4
4. Flow Regime Change
5. Sinuosity H M L S
6. Average Reach Gradient
7. Stream Canopy Closure 1 2 3 4
8. Other

9. General Comments:

CHAPTER 3

Stream Inventory Handbook

300 LEVEL II - HABITAT INVENTORY - FIELD PROCEDURE

- 310.1 Objectives
- 310.2 Standards
- 310.3 Equipment Needed
- 310.4 Procedure

STREAM INVENTORY HANDBOOK

300 - LEVEL II - RIPARIAN INVENTORY - FIELD PROCEDURE

310.1 - *Objectives*. The Level II survey is the basic inventory for determining the quality and quantity of fish habitat, and to obtain basic riparian and hydrologic condition. The objective of the Level II survey is to provide generally quantitative characterization of aquatic (fish/water) and riparian conditions at a watershed scale.

310.2 - *Standards*. Standards for the Field Phase are intended to obtain quantitative data. Specific standards for the procedure to accomplish the Field Phase are listed below. Data collected in the survey shall be at least as accurate as specified and all parameters listed will be included in the survey.

1. It is very important that the users of this handbook review and become familiar with the following paper: Hankin, D. and Reeves, G. 1988. *Use of Visual Methods for Estimating Fish Abundance and Habitat Areas in Small Streams*. This paper is a field guide which defines the standards, techniques, and quality controls needed in order to properly implement a Hankin and Reeves inventory. This paper is included as Appendix K.

2. The field crew member who does the visual estimates (observer) should continue to make the estimates at least through several stream reaches. **DO NOT CHANGE ESTIMATORS MID-WAY THROUGH A REACH! IF A CHANGE IN CALLERS IS NECESSARY, CHANGE AT THE START OF A NEW REACH BREAK!** This is critical for establishing the correction factor for visual estimates vs actual measurements for each observer.

3. **To develop statistically valid correction factors, a minimum of 10 pools, 10 riffles, and 10 glides will be measured for each observer on each stream.**

4. On longer streams, where the required number of measured units will be met, the minimum sampling frequency for pool, riffle, and glide units will be 10 percent. **On shorter streams, the frequency of measured units may need to be greater than 10 percent to achieve the necessary number of measured units as specified in #3 above.**

5. If a certain habitat type is uncommon (i.e., glides) 100 percent of those habitat units may have to be measured to achieve the required 10 measured units/habitat type.

6. The first unit of each habitat type to be measured will be selected randomly from a roll of the dice or a similar method. For example, if the roll of the die to determine the random start for measured pools was a "4," then you would start by measuring the 4th pool.

7. A system of photographs shall be established for the stream reach. A representative section of the stream reach and any significant features of interest, special habitats, problem areas, etc. within the reach shall be photographically documented. The beginning, ending, and representative habitat types for each reach should be documented with note to NSO and habitat type in the comments section of Form C.

8. A working map will be developed during the office procedure that will facilitate and expedite the field procedures portion of the survey. This working map has been described in the 210.1 section of this manual. Field notes and observations shall be noted on this map, since this map will serve as the foundation for a final survey map to be included in the watershed analysis package.

310.3 - *Equipment Needed.*

- Level II Survey Forms (R6-2500/2600-21, 22, 23, 24, 25, 30), as appropriate.
- Pencils.
- Clipboard.
- Four (4)-inch-to-a-mile (1/2 quads, 1:15,840 scale) USGS quads as base maps.
- USGS quads and aerial photographs.
- 150-foot tape measure.
- Good quality, heavy duty scale stick.
- Camera.
- Water velocity meter or velocity headrod.
- Thermometer.
- Clinometer or abney level.
- Plastic strip flagging and grease pencil/marker for use as needed.
- Waders/Hip boots and felt or corks.
- First Aid kit.
- Radio
- Snorkel, mask, wetsuit, drysuit, electroshocker

310.4 - *Procedure.* There are three phases needed to complete a Level II survey: (1) preplanning before starting field work (see level I); (2) field measurements (field phase) which include reach location data and riparian data for every reach sampled (Form B2, C, C1, C2, and C3, & D); and (3) data entry, analysis and summarization or reporting.

FINAL REACH IDENTIFICATION - FORM B2, R6-2500/2600-21

The purpose of the B2 form is to delineate FINAL reach boundaries for the surveyed channel. Several parameters on this form are similar to those found on FORM B1. Additional variables are measured/observed in the field to support the refined delineation of the reach. Common parameters between the two forms are: valley form, valley width, flow regime change, and average reach gradient. Additional field data include: channel entrenchment, sinuosity, dominant/subdominant substrate and beginning and ending of NSOs. Individual reach blocks in B2 shall be completed where applicable upon completion of last habitat unit in that reach.

Parameters in this form should be collected while in the field. Reaches shall begin and stop on specific habitat units (e.g., pools, riffles, or glides) that have accompanying natural sequence numbers. After those terminal units have been identified, final reach stratification can occur. *It is imperative to stop or start a reach in a habitat unit that can be specifically identified on the ground and is a permanent, fixed feature (waterfall, road crossing, cliff, etc.).* Again note that each observer must measure 10% of units they've observed per stream; hence, the number of observed/measured pairs is independent of stream reach. Once an observer has committed to calling in a reach, they must complete that reach. Surveyors are encouraged to place metal tags on mature trees at the end of reach specifying date, surveyors names, and reach number.

Following the final field reach delineation, total VALLEY length will be measured between the starting and ending points of the reach; this will allow a FINAL sinuosity value and average channel gradient to be calculated. Note that VALLEY LENGTH will be re-measured by map wheel and ruler in the office following completion of the field work in order to re-calculate the final sinuosity due to any changes in reach lengths.

Fill out a Form B2 For Each Stream Reach:

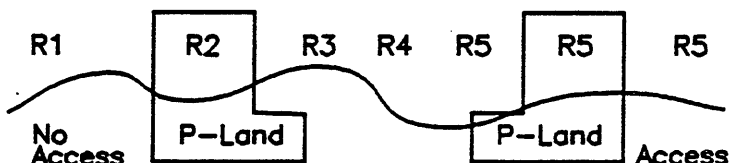
Form B2 Instructions

ATTRIBUTE

1. Reach Number

MEASUREMENTS/RECORDINGS

Enter the reach number beginning at the lowest point of the proposed survey, number the reaches sequentially upstream. **NOTE ON REACH NUMBERING:** Private land inholdings--If access is denied, treat the private land section as a separate reach. See diagram below. (FL:3 (e.g., 999)) Always note the NSO number of all private/NFS ownership boundaries under comments.



2. Natural Sequence Order (NSO)

Enter the starting and ending NSO's for each reach (**e.g., Reach 1 = NSO 1-55, then Reach 2 = NSO 56-etc.**). This information is extracted from Form C, following final reach delineation. In the case of private land where no access has been granted, DO NOT assign any NSO's for the reach, resume sequential NSO numbers at the next reach. (eg., in the above example, Reach 1, NSO = 1-203; Reach 2 (Private), NSO = *Blank*; Reach 3 (Public), NSO = 204-...). (FL:4 (e.g., 9999))

3. Flow

Enter actual measured flow recorded in cubic feet per second. At a minimum, take one measured flow at the starting point of the survey. If subsequent flows are taken, they should be measured at the beginning of new reach breaks. (FL:6 (e.g., 9999.00))

4. Channel Entrenchment

Use the following categories: deeply entrenched, (D); moderately entrenched, (M); or shallow entrenchment, (S). See Appendix E for channel profiles that match these categories. (FL:1 (e.g., 9))

Form B2 Instructions (Continued)

5. River Mile Enter river mile at both the starting and ending point of each reach. Use designated EPA river reach miles if available; if not, begin the mileage mark at the mouth of the stream, starting with RM-0 unless starting point is not at the mouth. The ending river mile of the lower reach is the beginning river mile of the adjacent, upstream reach, (eg., Reach 1, RM 0-1.1; Reach 2, RM 1.1-4.0; Reach 3, RM 4.0-5.2). Map wheels will be used to calculate river miles.(FL:5 (e.g., 9999.0))
6. Sinuosity Value Sinuosity is calculated for each reach using a 4":mile map; Use a map wheel to measure the actual channel distance from the beginning of the reach to the endpoint. Divide this number by the straight line distance between the two points. Rating is = or > 1.0. (FL:4 (e.g., 99.99))
7. Average Channel Gradient Calculate the channel gradient from a 1:24,000 scale topographic map once final reach boundaries have been delineated. Measure the stream channel beginning at the lowest elevation contour in the reach, and ending at the highest elevation. Calculate the gradient by subtracting the lowest elevation from the highest, and dividing that by the total channel length. (FL:3 (e.g., 999).
8. Valley Length The valley length will be determined following the final reach delineation. This is a straight line distance between the two points delineating the upper and lower end points of the reach, utilizing a topographical map and ruler. Enter in miles. (FL:4 (e.g., 99.99))
9. Valley Form Enter Valley Form code from Appendix D (FL:2 (e.g., 99))
10. Valley Width Class Enter the code which best describes the valley floor width. Valley floor width is the horizontal distance between the side slopes of the surrounding hills or mountains that confine the valley.
- 1 = <100 ft.
2 = 100-300ft.
3 = 300-600ft.
4 = >600ft.
- See Appendix D for illustrations. (FL:1 (e.g., 9))
11. Stream Canopy Cover Enter the code for final percent of the stream canopy closure from field observations. Use the canopy closure classification in the instructions for form B1. If densityometer is used state in comments. (FL:1 (e.g., 9))

Form B2 Instructions (Continued)

12. Dominant/Subdominant Substrate Enter the 2 most prevalent substrate types for the reach. See Attributes 7 & 8 on Form C for the substrate codes. (a-FL:2, b-FL:2)
13. Inner Riparian Zone Width Enter the inner vegetation zone width, starting at the edge of the bankful channel. If only one zone is identified, enter 100. The outer zone is calculated from subtracting the inner zone from 100 feet. (e.g., zone 1 = 0-60 feet, zone 2 = 60-100 feet.) This may change at reach breaks only, not within the reach. (FL:3)
14. Comments Write down any comments important to the aquatic/ riparian resources. This is a good place to clarify some of the entries made above. (FL:240)
15. Observer/Recorder Enter name of the observer (following DG format ie., J.SMITH) who makes the visual estimates for the reach. Note that the observer **cannot** change mid-reach. Enter the name of the recorder for the reach following dg format.
16. Date Enter the date form was completed (YY/MMM/DD).

A. State OR B. County 03 C. Forest 12 D. District 03
E. Stream Name: Example Creek
F. Watershed Code 17, 10, 02, 05 NFS 28, 14
G. USGS Quad: Tidewater
H. Survey Date: 92 / Aug / 28
Year / Month / Day
I. Name: R. Metzger

1. Reach # 1 2. NSO 1 to 110
3. Flow 10 cfs
4. Channel Entrenchment D M X S
5. River Mile 0.0 to 0.5
6. Sinuosity value 1.8
7. Average Channel Gradient 0.5%
8. Valley Length 0.3 miles
9. Valley Form 9
10. Valley Width Class 1 2 3 X 4
11. Stream Canopy Closure 1 2 3 X 4
12. Dominant/Subdominant a.) SA b.) GR
Substrate
13. Inner Riparian Zone Width 100
14. Comments Begin at confluence
with Aisen River
15. Observer: R. Metzger
Recorder: D. Netters
16. Date: 92/Sep/05
YY/MM/DD

1. Reach # 2 2. NSO 111 to 320
3. Flow 10 cfs
4. Channel Entrenchment D M S X
5. River Mile 0.5 to 1.5
6. Sinuosity value 1.3
7. Average Channel Gradient 2.0%
8. Valley Length 0.8 miles
9. Valley Form 8
10. Valley Width Class 1 2 X 3 4
11. Stream Canopy Closure 1 2 3 X 4
12. Dominant/Subdominant a.) CO b.) GR
Substrate
13. Inner Riparian Zone Width 100
14. Comments
15. Observer: R. Metzger
Recorder: D. Netters
16. Date: 92/Sep/05
YY/MM/DD

1. Reach # 3 2. NSO to
3. Flow
4. Channel Entrenchment D M S
5. River Mile 1.5 to 2.0
6. Sinuosity value 1.3
7. Average Channel Gradient 2.0%
8. Valley Length 0.4 miles
9. Valley Form 8
10. Valley Width Class 1 2 X 3 4
11. Stream Canopy Closure 1 X 2 3 4
12. Dominant/Subdominant a.) b.)
Substrate
13. Inner Riparian Zone Width
14. Comments Private land - Not Surveyed
15. Observer:
Recorder:
16. Date: 92/Sep/05
YY/MM/DD

1. Reach # 4 2. NSO 321 to 500
3. Flow 6 cfs
4. Channel Entrenchment D X M S
5. River Mile 2.0 to 3.0
6. Sinuosity value 1.2
7. Average Channel Gradient 5.0%
8. Valley Length 0.8 miles
9. Valley Form 2
10. Valley Width Class 1 X 2 3 4
11. Stream Canopy Closure 1 2 3 4 X
12. Dominant/Subdominant a.) BR b.) CO
Substrate
13. Inner Riparian Zone Width 100
14. Comments End survey at
Slippery Rock Falls - anadromous
barrier
15. Observer: R. Metzger
Recorder: D. Netters
16. Date: 92/Sep/05
YY/MM/DD

STREAM HABITAT DATA - FORM C, R6-2500/2600-30

The Stream Habitat Data Form - The following items should be recorded on Form C for the reaches to be surveyed. Each Forest should establish a standard for "right bank" and "left bank" orientation. This orientation shall remain consistent over the forest once established. NOTE: USGS standard establishes orientation while looking downstream.

Each estimated dimensional variable will be measured at each "nth" unit. The measured information will be placed in the fields below each corresponding estimate. In addition, items 16-28 are to be entered on this line.

(NOTE INSTRUCTIONS FOR ATTRIBUTES A - G ARE LISTED ON THE FORM A INSTRUCTIONS)

Form C Instructions

ATTRIBUTE

MEASUREMENTS/RECORDING

I. Reach Number

Utilize Form B2 to identify the reach. Reaches shall be numbered sequentially, starting with the downstream most reach (e.g., 1, 2, 3,...). NOTE THAT THE FINAL REACH BOUNDARIES MAY CHANGE FOLLOWING VERIFICATION DURING THE FIELD PHASE. PRIOR TO COMPUTER DATA ENTRY, FINAL DELINEATION MUST OCCUR, AND THE TRUE REACH NUMBER BE ASSIGNED TO THE RESPECTIVE HABITAT UNITS. When starting a new reach, record data on a new form C. This will facilitate data entry, and minimize data entry errors. **MAKE SURE NSO'S FROM B2 COINCIDE WITH THE NSO'S ON THE C FORM FOR EACH REACH.**

J. Sampling Frequency

Enter the frequency of sampling the *Nth* unit (e.g., if sampling habitat types at a 20% frequency, enter 5) for each habitat type.

Sampling frequency must be sufficient to ensure at least 10 measured pools, 10 measured riffles, and 10 measured glides for each observer on each stream. On longer streams where the required numbers of measured units can be met, a minimum of 10% of pool, riffle, and glide units will be measured. Shorter streams may require a much greater sampling frequency to achieve the necessary number of measured units.

If a certain habitat type is uncommon (i.e., glides) 100 percent of those habitat units may have to be measured to achieve the required 10 measured units/habitat type.

The * denotes the additional categories that require entries for measured units. Do not fill in these categories in the non-measured habitat units.

1. Natural Sequence Order (NSO)

Enter a different natural sequence order number for each habitat unit. NSOs should be entered in the same order as habitat units are encountered in the field survey, beginning with the first habitat unit, (e.g., 1,2,3,...).

Form C Instructions (continued)

The numbering sequence shall remain consistent between reaches, (if Reach 1 ends at natural sequence #203, then Reach 2 shall begin at natural sequence #204). The only exception to this is a Private land reach where access has not been granted. In this case, a reach number is assigned to the private land, but no NSO's are identified. Sequential number of NSO's resumes in the *next* upstream reach, (eg., if Reach 2 is private land, no access, then NSO's are as follows: Reach 1 = NSO 1-203; Reach 2 = NSO none; Reach 3 = NSO 204-251...).

All side channels (S) and tributaries (T) should be treated as individual habitat units and assigned individual NSO numbers. They should be assigned the next incrementally higher NSO than the main channel habitat unit which they flow into. When multiple habitat units (tributaries and side channels) converge upon the mainstem simultaneously, number them in a clock-wise order. See Appendix F. Identify the unit at which a side channel leaves the main channel and returns in the comments. (FL:4 (e.g., 9999))

2. Habitat Type and Number

Enter the habitat unit type and number for each unit. Valid Habitat Codes include:

P = Pool
R = Riffle
G = Glide
S = Side Channel
T = Tributary
D = Dry Channel
C = Culvert (Form C1)
F = Special Cases (chute, falls, dam--Form C2)

See Appendix K for descriptions/illustrations of each habitat unit. Work with Forest personnel to develop a consistent standard for pools, riffles, glides, and side channels.

Habitat type numbers will be ordered consecutively upstream from the starting point through the ending point of the survey. (eg., if Reach 1 ends at P25, the next pool encountered in Reach 2 would be P26.)

In order to consider a habitat type as a unit, the habitat length must be greater than the wetted width. If a unit does not meet this criteria, do not consider it as a separate unit. For extremely long habitat units, (e.g., riffles 900 feet long) consider stratifying them into smaller more manageable lengths. Assign each of the stratified segments a **different** NSO and habitat number (eg. separate a long riffle into NSO 20 - R4, NSO 21 - R5, and NSO 22 - R6).

Form C Instructions (continued)

Prefix each measured habitat unit with an "M" so that these are apparent during data entry. (Example: P23 = estimated unit, MP23 = measured values). Only habitat types P,R, and G will have estimated/ measured pairs. Dimensional variables for all other habitat types will be considered to be measured whether they are or not (eg.,they will have a correction factor of 1.0).

For side channels (S), enter only wetted length, width, and depth. Habitat numbering sequence should follow the numbering convention specified under Natural Sequence Order number. Do not include dry side channels. Do not break out individual habitat units (pools, riffles) within side channels.

Consider braided channels to be side channels. Identify the main channel and treat secondary channels as side channels.

For Tributaries (T), enter the length, width, depth, and substrate of the first habitat unit and the water temperature.

For Dry Channels (D), enter only unit length. Enter 0 for wetted width.

For Special Cases (C or F), enter all information required for Forms C1 or C2.

(FL:5 e.g., MP999)

3. Habitat Length

Enter the ocularly estimated wetted length for each habitat unit. *The length will be ocularly ESTIMATED at each unit and ESTIMATED and MEASURED at each Nth unit. Estimated and measured (E&M) values shall be reported to the nearest foot.* (FL:5 (e.g., 999.0))

4. Habitat Width

Enter the ocularly estimated mean wetted width for each habitat unit to the nearest foot. *The width will be ocularly ESTIMATED at each unit and ESTIMATED and MEASURED at each Nth unit.* (FL:4 (e.g., 999.0))

5. Max Depth

Enter the ocularly estimated maximum depth for each unit. *The maximum depth will be ocularly ESTIMATED at each unit and ESTIMATED and MEASURED at each Nth unit; unless water conditions permit the measurement at each unit. If each unit is measured, enter this dimension as both "estimated" and "measured." This will artificially generate a correction value of 1.0. Maximum depth can be easily measured at each habitat unit with a scale stick if the depths are typically less than 4 feet.* (EFL:3 (e.g., 99.9))

Form C Instructions (continued)

6. Depth at Pool Tail Crest

Enter the estimated/measured depth at pool tail crest (riffle crest) for every pool habitat unit. This location is upstream of the point where the water surface slope breaks into the downstream riffle. Measure the maximum depth at this point along the width of the hydraulic control feature that forms the pool. This measurement is for calculating residual pool volume (e.g., maximum depth minus pool tail crest depth = maximum residual pool depth). *The depth will be ocularly ESTIMATED at each pool unit and ESTIMATED and MEASURED at each Nth pool unit, unless depth at pool tail crest can be easily measured at each pool tail with a scale stick. (EFL:3 (e.g., 99.9))*

7. Stream Bed Substrate (Dominant)

Enter the ocularly estimated dominant and subdominant substrates within *each unit* by area. Use the following size classes and qualifiers:

SA = Sand, Silt, and Clay	(0.08in)
GR = Gravel (pea to hardball size)	(0.08-2.5in)
CO = Cobble (hardball size to basketball size)	(2.5-10in)
SB = Small Boulder	(10-40in)
LB = Large Boulder	(>40in)
BR = Bedrock	(FL:2 (e.g., 99))

8. Stream Bed Substrate (Subdominant)

Enter the estimated sub-dominant substrate within *each unit* by area. Use the above size classes and qualifiers.

9. Pieces LWD

Enter the number of pieces of large woody material within the bankfull channel for each habitat unit. This includes live, leaning trees that have the potential to fall into the stream.

To be included, leaning trees must lean over the area defined by the bankfull channel width; if it leans, but is not within this area, do not count it as woody material. If leaning trees (potential LWD) are included in the LWD count, note the approximate numbers or the percentage of total LDW pieces which leaning trees make up under Comments.

Enter the number of pieces of large woody material in each of the three size classes: Brush, Small, Large. Use the following minimum diameter and length criteria:

East Side Forests:

- (9) B = Diameter > 6in, length > 20ft
- (10) S = Diameter > 12in, length > 35ft
- (11) L = Diameter > 20in, length > 35ft

Form C Instructions (continued)

West Side Forests

(9) B = Diameter > 12in, length > 25ft

(10) S = Diameter > 24in, length > 50ft

(11) L = Diameter > 36in, length > 50ft

If the woody material does not meet the length criteria, but is longer than 2 times the bankfull channel width, count the piece in the appropriate size class based on the minimum diameter criteria.

Make note of log complexes, logjams, and rootwads under Comments. (FL:2 (99))

12,13,14. Total Cover

(12): Percent - Enter the code for the estimated cover category for each P, R, or G unit for the desired species and size class(es) of fish. What is cover for young of the year salmonids will not suffice for age 1+ fish. Visualize the wetted surface area of the unit from overhead and record the percentage class of this area that is occupied by cover: (FL:1 (e.g., 9))

1 = 0 to 5%	total cover
2 = 6 to 20%	total cover
3 = 21 to 40%	total cover
4 = > 40%	total cover

(13,14): Cover Type - Enter the dominant (14) and subdominant (15) cover types for each P, R, or G unit. Use the following cover codes: (FL:1 (e.g., 9))

U= Undercut banks

S= Substrate

D= Depth > 3 feet

H= Overhanging vegetation within 10" above the water surface

W= Wood Material

T= Turbulence

A= Aquatic/Emergent Veg

15. Bankfull Width

Enter the MEASURED bankfull width at each Nth riffle. Select riffles that have a straight orientation with no evidence of high water piling on either side of the active bank. Bankfull is defined by the following bankfull indicators: a change in vegetation (i.e., from none to some); staining from mining operations (i.e., a stained line); a change in the scour line (exposure of nodes, roots, etc.); a change in bank topography (top of a point bar, break in slope); a change in particle size (one of the best indicators); a line of debris (do not use debris hanging in vegetation). Do not use an area with an undercut bank, bank slumping will give a false reading.

Form C Instructions (continued)

16. Bankfull Depth

Enter the MEASURED bankfull depth at each *Nth* riffle. The measurement will be made at the same location as the bankfull width and is obtained by measuring the distance from the elevation of the bankfull width to the deepest part of the riffle.

17. Embeddedness

Enter Y for Yes, N for No for each measured pool, riffle, and glide unit. This includes pools, riffles and glides. If the ocularly estimated cobble embeddedness in the unit is >35% by volume, enter Y. If there is no cobble, use gravel embeddedness. If substrates for the habitat unit DO NOT contain either gravel or cobble, insert the letter A. See Appendix G for illustration of embeddedness. (FL:1 (e.g., 9))

18,19. Streambank Substrate

Enter the dominant (19) and subdominant (20) substrates of the upper 1/3 of the bankfull channel streambanks for each *Nth* habitat unit. Use the codes for substrate as shown in #7 (substrate) above. See Appendix H for illustrations of streambank. (FL:2 (e.g., 99))

20. Streambank Ground Cover

Enter the percentage of ground cover for the upper 1/3 of the streambank for each *Nth* habitat unit either vegetatively or physically armored against scour from bankfull flow. Take an average of both banks and combine for a total percentage figure. Use the following percentage classes:

- 1 = 0-25%
- 2 = 26-50%
- 3 = 51-75%
- 4 = 76-100%

Armoring can be provided by bedrock, substrate materials, vegetation and their roots, woody material, mosses, etc. (FL:1 (e.g., 9))

21,22,23. Floodplain Vegetation (Zone 1)

(21): Enter the existing floodplain vegetation successional class within the inner zone for each *Nth* unit by the following codes (see Appendix I for illustration and definitions of successional stages). (FL:2)

DIAMETER CLASS

GF = Grassland/Forb Condition	NA
SS = Shrub/Seedling Condition	(1.0-4.9")
SP = Sapling/Pole Condition	(5.0-8.9"dbh)
ST = Small Trees Condition	(9.0"-20.9"dbh)
LT = Large Trees Condition	(21"-31.9"dbh)
MT = Mature Trees Condition	(> 32"dbh)

Form C Instructions (continued)

The width of the inner zone (Zone 1) is specified on Form B2. Once a width for the zones has been established, that distance must be maintained throughout the reach.

(22,23): Enter the dominant and subdominant species of vegetation growing on the streambank for each *Nth* unit utilizing the species categories listed below.

If species are in seral class GF, enter GF.

If species are in seral class SS, enter SS with the optional corresponding height class code (e.g. SS3, if shrubs are between 5 and 10 feet tall).

If seral class is SP, ST, LT, or MT, use the following codes to identify dominant and subdominant conifer and/or hardwood species. Forests may add to this list to include additional vegetation species. (FL:3)

Hardwood:

HA = Alder

HB = Bigleaf maple

HC = Cottonwood, ash, poplar

HD = Dogwood

HE = Elderberry

HL = Liveoak, canyon

HM = Madrone

HO = Oak, Oregon white, California black

HQ = Quaking aspen

HT = Tanoak

HV = Vine Maple

HW = Willow

HX = Other

Form C Instructions (continued)

Conifer:

CA = Subalpine fir, mountain hemlock, whitebark pine

CC = Cedar, western red

CD = Douglas fir

CE = Subalpine fir - engelmann spruce

CF = Fir, silver and noble

CH = Hemlock, western

CJ = Juniper

CL = Lodgepole pine, shore pine

CM = Mountain Hemlock

CP = Ponderosa pine, Jeffrey Pine

CQ = Western white pine

CR = Red fir

CS = Spruce, sitka

CT = Port Orford cedar

CW = White fir, grand fir

CY = Yew

CX = Other

Shrub height classification is an optional field and applies only to seral class SS. Use the following categories:

1 = 0'-2'

2 = 2'-5'

3 = 5'-10'

4 = > 10'

Form C Instructions (continued)

Examples:

Eastside - If seral stage is Grassland, with grasses dominant and shrubs 3 feet tall subdominant: a: GF, b: GF, c: SS2. If seral stage is shrub/sapling dominant, with shrubs and saplings 30 feet tall and alder subdominant: a: SS, b: SS4, c: HA.

Westside - Seral stage is large trees with Douglas fir dominant and alder subdominant: a: LT, b: CD, c: HA.

24,25,26. Floodplain Vegetation (Zone 2)

Enter the vegetation successional class for each Nth unit for the outer delineated zone. Use successional classes and vegetation species identified in 21, 22, and 23 above.

27. Water Temperature

a. Take stream temperatures within the main stream channel at least 3 times a day (morning, noon, late afternoon). Enter to the nearest degree.

NOTE: Temperatures should be recorded on measured units only.

Stream temperatures should also be recorded for each tributary unit which is assigned an NSO. (FL=2)

b. Enter the military time when temperatures are taken (to the nearest hour, 1-24). (FL=4)

28. Bank Stability

Measure the lineal distance of actively eroding bank along both sides of the active channel at every Nth unit. An eroding bank is characterized by any one, or combination of the following factors: bare exposed colluvial or alluvial substrates, exposed mineral soil, evidence of tension cracks, or active sloughing.

29-33. Optional Fields

Place any additional information collected at habitat units in these columns. Forests will need to set up a separate data table in Oracle to analyze this information.

34. Comments

Enter comments regarding any of the above evaluations and photos; or geomorphological, hydrologic, or biological observations either here on Form C, or on Form C3. For culverts use Form C1, and for falls, chutes, and dams use Form C2 to document specific information regarding these features. Stream gradient measurements should be made on a frequent basis and documented here. Shoot the gradients over an area that contains several habitat units (no less than 150 feet or 45 meters). Other suggested notable features to note are:

Fish passage: jams, barriers, fish habitat improvement opportunities, etc.

Watershed concerns: slides, erosion areas, streambank damage, watershed rehabilitation potential, etc.

Form C Instructions (continued)

Other: diversions, mining, dredging, filling, riprap, etc. Also include reaches that are within Wild and Scenic rivers and wilderness areas.

Tributaries: Note the habitat unit at the confluence, estimated discharge, gradient immediately upstream of mouth and percent contribution to the flow of the main stem.

End of Survey: Note the reasons for ending the survey at a given point. If possible mark beginning and end of reach with metal tag to tree and define in comments section.

This information will give the reviewer insight as to the reasoning for ending the survey, and will minimize the need to re-examine that point in the watershed.

NOTE: *Description of underlined features should include the location and an objective description of situation.* Photographs are helpful in recording notable features. General characteristics should be noted in comments section for other features noted.

PG

31

A. State OR B. County 03 C. Forest 12 D. District 03
E. Stream Name: Example Creek
F. Watershed Code 17, 10, 02, 05 NFS 28.H; ., ., ., .
G. USGS Quad: Tide water
H. Survey Date: 92 / Aug / 28
Year / Month / Day

32

SPECIAL CASES - FORMS C1 AND C2, R6-2500/2600-23, AND 24

These forms are to supplement information collected on culverts, falls, chutes and dams that have been noted in the Comments section on FORM C. The forms are self explanatory. If photos are taken of the feature, note the photo # and film roll # in the comments section of Form C, as well as in Attributes 13 and 10 of Forms C1 and C2.

A. State OR B. County 03 C. Forest 12 D. District 03
 E. Stream Name: Example Creek
 F. Watershed Code 17, 10, 02, 05 NFS 28, 4; ., ., ., .
 G. USGS Quad: Tidewater
 H. Survey Date: 92 / Aug / 28
 Year/ Month /Day

1. Reach # 2 2. Natural Sequence Order # 120 3. Culvert # 1
 4. Type of structure (check)
 Round Pipe ☐ Box ☐ Arch ☐ Open Arch ☐ Open Box ☐ Eliptical ☐
 5. Length of Structure 35 (ft) 6. Diameter or width 6 (ft)
 7. Gradient of Structure 1.0 % 8. Are Baffles Present? N
 9. Jumping distance into culvert from pool: Height 0.0
 10. Pool present below structure (circle) Yes No
 11. Pool Length 40, Width 14, Depth 5.5 12. Stream Seg. Id.
 13. Stream above culvert: Width 10, Gradient 2.0
 14. Obs/Rec R. Metzger / D. Netters

1. Reach # 4 2. Natural Sequence Order # 360 3. Culvert # 2
 4. Type of structure (check)
Round Pipe ☐ Box ☐ Arch ☐ Open Arch ☐ Open Box ☐ Eliptical ☐
 5. Length of Structure 120 (ft) 6. Diameter or width 4 (ft)
 7. Gradient of Structure 2 % % 8. Are Baffles Present? N
 9. Jumping distance into culvert from pool: Height 1.0
 10. Pool present below structure (circle) Yes No
 11. Pool Length 20, Width 12, Depth 3.0 12. Stream Seg. Id.
 13. Stream above culvert: Width 6, Gradient 5 %
 14. Obs/Rec R. Metzger / D. Netters

1. Reach # 2. Natural Sequence Order # 3. Culvert #
 4. Type of structure (check)
 Round Pipe ☐ Box ☐ Arch ☐ Open Arch ☐ Open Box ☐ Eliptical ☐
 5. Length of Structure (ft) 6. Diameter or width (ft)
 7. Gradient of Structure % 8. Are Baffles Present?
 9. Jumping distance into culvert from pool: Height
 10. Pool present below structure (circle) Yes No
 11. Pool Length , Width , Depth 12. Stream Seg. Id.
 13. Stream above culvert: Width , Gradient
 14. Obs/Rec

SPECIAL CASES (FALLS) FORM C2
R6-2500/2600-24

Page: 1 of 1

A. State OR B. County 03 C. Forest 12 D. District 03
E. Stream Name: Example Creek
F. Watershed Code 17, 16, 02, 05 NFS 28, H; , , ,
G. USGS Quad: Tidewater
H. Survey Date: 92 / Aug / 28
 Year / Month / Day

1. Reach # 4 2. Natural Sequence Order # 451
3. Falls Number: 1
4. Falls/ (Chute) Dam (circle one)
5. Stream Survey Mile: 2.7 6. Topo map elevation: 300
7. Size: Length 20 Width 15 Height 8
8. Gradient: 50 %
9. Is pool present below structure (circle one) (Yes) No
10. Pool Length 35 Width 20 Depth 3.5
11. Obs/Rec: R. Metzger / D. Nethers
12. Comments: Not a fish barrier

1. Reach # 4 2. Natural Sequence Order # 500
3. Falls Number: 2
4. (Falls) Chute/ Dam (circle one)
5. Stream Survey Mile: 3.0 6. Topo map elevation: 350
7. Size: Length 50 Width 20 Height 30
8. Gradient: 200 %
9. Is pool present below structure (circle one) (Yes) No
10. Pool Length 50 Width 25 Depth 5.5
11. Obs/Rec: R. Metzger / D. Nethers
12. Comments: End anadromous habitat

1. Reach # 2. Natural Sequence Order #
3. Falls Number:
4. Falls/ Chute/ Dam (circle one) #
5. Stream Survey Mile: 6. Topo map elevation:
7. Size: Length Width Height
8. Gradient: %
9. Is pool present below structure (circle one) Yes No
10. Pool Length Width Depth
11. Obs/Rec:
12. Comments:

FISH USE AND RELATIVE ABUNDANCE - FORM D, R6-2500/2600-30

Form D is to be used to record fish information. The survey intensity may vary between Forests/Districts. *At a minimum, fish information should be recorded at each 10th pool, 15th riffle and 20th glide and entered on Form D.* Snorkling, electrofishing, or seine methods may be used to gather this information. **NOTE:** This information will be used to identify fish species composition and range. It is not meant to provide population estimates.

(NOTE INSTRUCTIONS FOR ATTRIBUTES, A - H ARE LISTED IN FORM B1 INSTRUCTIONS)

Form D Instructions

ATTRIBUTE

MEASUREMENTS/RECORDING

- | | |
|---------------------------------|---|
| I. Reach Number | Fill out only after the field survey has been completed. |
| J. Method | Enter the abbreviation for sampling technique: Seine (S), Snorkel (SN), Electroshock (E). (FL:2 (e.g., 99)) |
| 1. Natural Sequence Order (NSO) | Enter the natural sequence order as listed in Form C. (FL:4 (e.g., 9999)) |
| 2. Habitat Type and Number | Enter the habitat type and number as listed in Form C, Attribute #2. (FL:5 (e.g., 99999)) |
| 3. Species | Enter the actual count (by species) of the fish observed within adult and juvenile categories at each sampled habitat unit. Use the species codes as listed in Appendix B.

Juveniles are defined as sub-legal individuals. Adults are defined as individuals of catchable legal size. (FL=6) |
| 4. Comments | Enter comments regarding any of the above evaluations and document photos; or geomorphological, hydrologic or biological observations. |

Page: 1 of

J. METHOD:

Snorkel
(SN)

Electroshock
(E)

37

CHAPTER 4

Stream Inventory Handbook

400

REPORTS

410.1

Objectives

410.2

Sample Report Format

Stream Inventory Reports/Report Writing

410.1 - Objectives. Interpretive reports are a key element of any inventory. Data without a report is next to useless, and will simply occupy file space for a number of years and either be discarded or archived. To ensure this doesn't occur, **annual interpretive reports** for inventories completed during the field season **are required**.

The ingredients for a good usable report includes enough detail to describe the current situation in terms understandable to the intended audience, without being verbose. Displaying tables and graphs without good interpretation is almost as useless as not writing a report in the first place, and interpretation goes far beyond simply regurgitating the figures displayed. This is an art in itself and requires the expertise gained with on the job experience. At a minimum, review and input from a journey level professional is required to ensure adequacy of management implications, and interpretations.

Finally, report presentation is also important. Taking the extra steps to bind and illustrate (ie, a picture is worth a thousand words) can spell the difference between being used, or gathering dust in a corner. An economical spiral binding together with photo's, graphs and charts is sufficient in most cases.

410.2 - Sample Report Format. Following is a recommended outline along with a list of items that should be considered in developing the report. Note that each item should be considered, but not necessarily addressed. Local conditions and needs will dictate the items included. This is not an exhaustive list and the Forests are encouraged to add details necessary to accurately portray local conditions.

STREAM INVENTORY REPORT FORMAT

- I. Cover Page**
- II. Executive Summary**
- III. Basin Summary**
- IV. Reach Summaries**
- V. Summary Tables**
- VI. Maps**
- VII. Photos**

I. COVER PAGE

STREAM NAME STREAM SURVEY REPORT

SURVEYORS:

SURVEY DATES:

SURVEY DISTANCE:

Class I
Class II
Class III
Total

LOCATION:

County:

Forest:

District:

TRI Compartments:

Drainage:

Tributary to:

Mouth Location:

WATERSHED:

NFS Watershed No.:

Watershed Area:

Stream Order:

Stream Class:

Stream Length:

FISHERIES:

Fish Observed:

Fish Distribution:

II. EXECUTIVE SUMMARY

A. Discussion of the Existing Situation

1. Provide a brief discussion of the existing conditions within the basin: focus on species present, habitat availability and condition.
2. Compare existing condition to known pertinent issues and concerns.
3. This section should answer the basic questions "how much is there, and what kind of shape is it in?".

B. Issues, Concerns and Opportunities

1. Present known information on TES species.
2. Describe conditions in the context of the Forest Plan Standards and Guidelines - do conditions reflect stated objectives in the Forest Plan?
3. Desired Future Condition - on offshoot of the Forest Plan, these will generally be numeric values associated with the objectives. Discuss quantitatively existing stream/channel condition in context to where the system should be as defined by DFC values. Identify preliminary costs, types of treatment prescriptions, and time frames for bringing the channel to DFC values.

C. Management Conclusions

1. Interpretation of how the existing conditions relates to the above ICO's: magnitude and importance; implications on resources and resource management; solutions.

III. BASIN SUMMARY

A. Introduction

past history
ownership
access

B. Watershed/Geomorphology

basin orientation
tributaries (peren/inter)
seeps and springs
valley bottom configuration
side slopes %
soil types and conditions

palmate or pinnate
flow regime
timber mgt. & road activities
floodplain width
vegetative cover

C. Riparian Habitat

general conditions
types of riparian vegetation
previous, current, or planned harvest activity

presence of wetlands
beaver activity (if any)
canopy/shade

D. Fisheries

P:R:G ratio
effective cover
fish passage
large woody debris quantity and complexity

Spawning gravel quantity and quality
pool quantity and quality
relative fish abundance and distribution

E. Management Implications

1. Compare data with standards and guidelines in Forest Land Management Plan and desired future condition for fish habitat, riparian habitat, and watershed (does it meet?). This will likely be in the areas of sedimentation, large woody debris, pools, shade, temperature, and ?. If it doesn't meet the standards, what are the possible reasons.
2. Identify effects of land management activities and natural events (i.e., floods and land mass movements).
3. Survey wasn't site specific enough (i.e., didn't pick up plunge pools and that was all that you had.).
4. Identify needs and opportunities for fish habitat, riparian habitat, and watershed improvement/rehabilitation.

IV. REACH SUMMARIES

A. Introduction

past history
ownership
access

B. Watershed/Geomorphology

basin orientation
tributaries (peren/inter)
seeps and springs
valley bottom configuration
side slopes %
soil types and conditions

reach length
flow regime
timber mgt. & road activities
floodplain width
vegetative cover (kinds)
palmate or pinnate

C. Riparian Habitat

general conditions
types of riparian vegetation
previous, current, or planned harvest activity

presence of wetlands
beaver activity (if any)
canopy/shade

D. Fisheries

P:R:G ratio
effective cover
fish passage
large woody debris quantity and complexity

Spawning gravel quantity and quality
pool quantity and quality
relative fish abundance and distribution

E. Management Implications

1. Identify parameters and compile data needed to evaluate the standards, guidelines, and desired future condition for fish habitat, riparian habitat, and watershed in your Forest Land Management Plan (does it meet?). This will likely be in the areas of sedimentation, large woody debris, pools, shade, temperature, and ?. If it doesn't meet the standards, what are the possible reasons.

2. Identify effects of land management activities, natural events (i.e., floods and land mass movements).

3. Survey wasn't site specific enough (i.e., didn't pick up plunge pools and that was all that you had).

4. Identify needs and opportunities for fish habitat, riparian habitat, and watershed improvement/rehabilitation.

V. SUMMARY TABLES

photo copies of SMART summary table printouts

VI. MAPS

reach breaks
roads
major slides or land failures

tributaries
harvest areas

barriers
meadow/wetlands

Make this map legible and neat. Don't color code anything unless you plan on never making a copy of it.

VII. PHOTOGRAPHS

VIII. APPENDICES

List of pertinent standards, guidelines, and desired future conditions from LMP.

Stream inventory procedure information: brief description, date and version number of the stream inventory handbook.

APPENDIX A

Watershed Codes

Nationally, the US Geological Survey and the Water Resources Council have established a coordinated watershed delineation and coding system which is referred to as the Hydrologic Unit Codes (HUC). This system is hierarchical and is comprised of Region, Subregion, Accounting Unit, and Cataloging Unit. The Accounting Unit is generally referred to as a river basin and the Cataloging Unit is usually known as a subbasin. An example of this type of coding is:

Region	Pacific Northwest	17
Subregion	Upper Columbia River	1707
Accounting Unit	Deschutes River Basin	170703
Cataloging Unit	Upper Deschutes River Subbasin	17070301

The Forest Service has added an additional 2 levels of finer resolution to the HUC coding system to define specific watersheds within a Forest. The structure for these two fields (watershed and subwatershed) is displayed below.

Watershed	Tumalo Creek	17070301 02
Subwatershed	Bridge Creek	17070301 02A

Watersheds can be divided into a maximum of 25 subwatersheds denoted by a letter of the alphabet. The letter "O" cannot be used to designate a subwatershed because of the potential to mistake it for zero. All districts should have a good quality watershed map showing the location of all watersheds and subwatersheds.

The Region 7 Standardized Stream Survey Methodology has adopted additional criteria to specifically identify every stream and tributary within a subwatershed.

Under NFS code on Form A there are up to four entries for stream mile measurements to identify the specific stream within the NFS watershed (2 digit code) and subwatershed (1 letter code). These four entries (each 4 characters long) are used to record measured stream miles upstream of the confluence with the next highest (hierarchical order) stream. **ALL MILEAGES UNDER THE NFS CODE SHOULD START AT THE MOUTH OF THE MAINSTEM WHICH FORMS THE NFS SUBWATERSHEDS AND PROCEED UPSTREAM UNTIL THE SPECIFIC SURVEYED TRIBUTARY IS REACHED.**

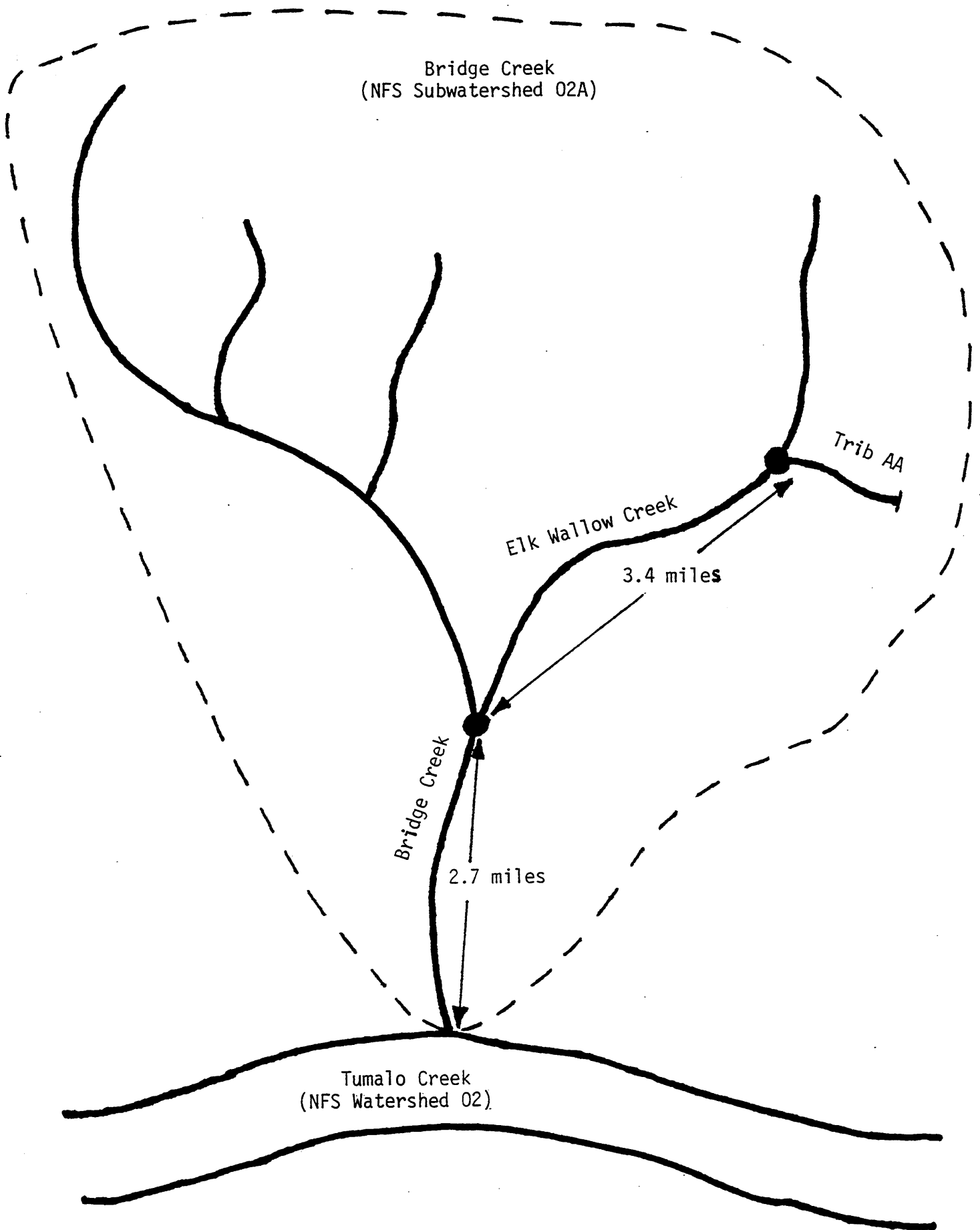
As an example, Tributary AA is a stream to be surveyed. This unnamed tributary flows into Elk Wallow Creek at river mile 3.4, which then flows into Bridge Creek at river mile 2.7 (refer to diagram). The four fields must have 4 digits (2 before and two after the decimal) in order for the program to accept them during data entry. Using the above river mileages, stream delineation coding would look something like this:

17070301,	02,	A,	02.70,	03.40,	_____	_____
HUC code	Water-	Sub-	River miles			
	shed	basin				
	code	code				

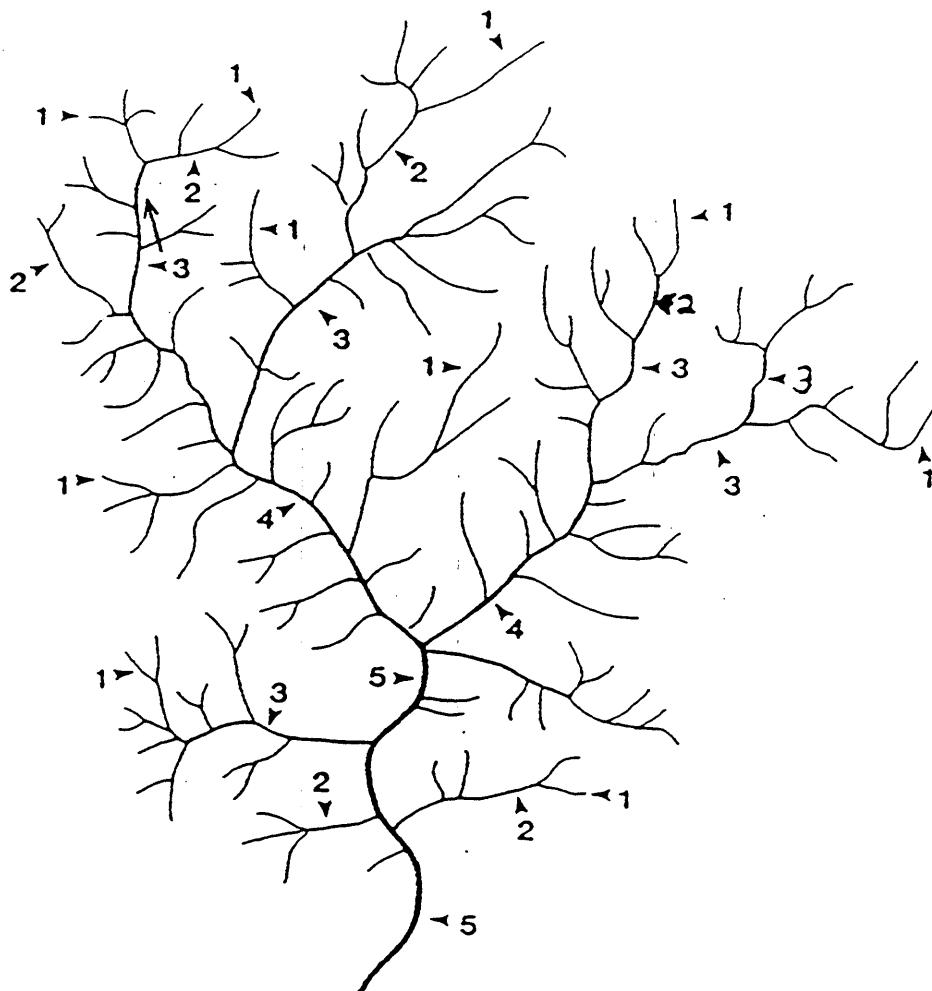
This procedure can be taken an additional two steps to further delineate other tributaries. These mileage measurements designate nodal points at confluences of streams.

To ease clarification, the tributary that has the greatest length from the mainstem confluence to the headwaters will be considered as the mainstem.

In cases where the mouth of the mainstem is an estuary or lake, estimate the stream mileages for tributary junctions along your best guess of what would be the main channel (based on topographical features).



APPENDIX B



STREAM ORDERS

Stream order: The designations (1, 2, 3, etc.) of the relative position of stream segments in a drainage basin network: the smallest, unbranched, intermittent tributaries, terminating at an outer point, are designated order 1; the junction of two first-order streams produces a stream segment of order 2; the junction of two second-order streams produces a stream segment of order 3, etc. Use of small-scale maps (<2"/mile) may cause smaller streams to be overlooked, leading to gross errors in designation. Ideally designation should be determined on the ground or from large-scale air photos.

APPENDIX C

ABBREVIATIONS FOR FISHES IN OREGON AND WASHINGTON

Use the following 4 digit codes for describing the fish identified on the Forest. Note the first 2 alpha characters are the first 2 letters of the genus, and the second 2 alpha characters are the first 2 letters of the species. For the Forest index, please note the common name for the species. Below is a partial list of game species; be sure to identify non-game species on your forest.

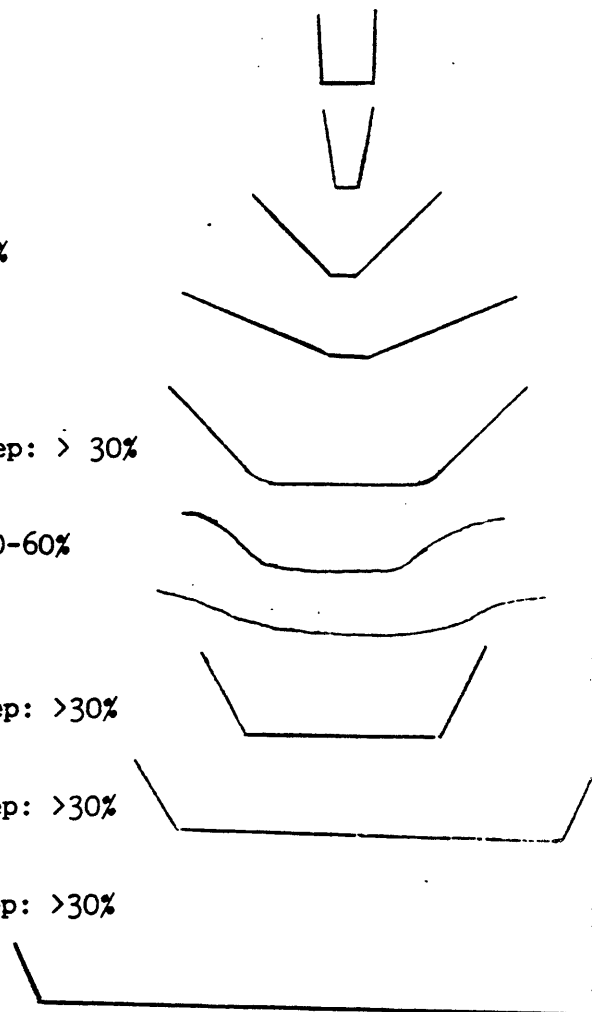
<u>CODE</u>	<u>GENUS AND SPECIES</u>	<u>COMMON NAME</u>
Onne	<i>Onchorhynchus nerka</i>	sockeye salmon
Onts	<i>Onchorhynchus tshawytscha</i>	chinook salmon
Onke	<i>Onchorhynchus keta</i>	chum salmon
Ongo	<i>Onchorhynchus gorbushcha</i>	pink salmon
Onki	<i>Onchorhynchus kisutch</i>	coho salmon
Onmy	<i>Onchorhynchus mykiss</i>	steelhead, rainbow, redband
Oncl	<i>Onchorhynchus clarki</i>	cutthroat trout
Ontr	<i>Onchorhynchus trutta</i>	brown trout
Saco	<i>Salvelinus confluentus</i>	bull trout
Safo	<i>Salvelinus fontinalis</i>	brook trout
Prwi	<i>Prosopium williamsoni</i>	mountain whitefish

APPENDIX D

VALLEY FORM CODES

ILLUSTRATION

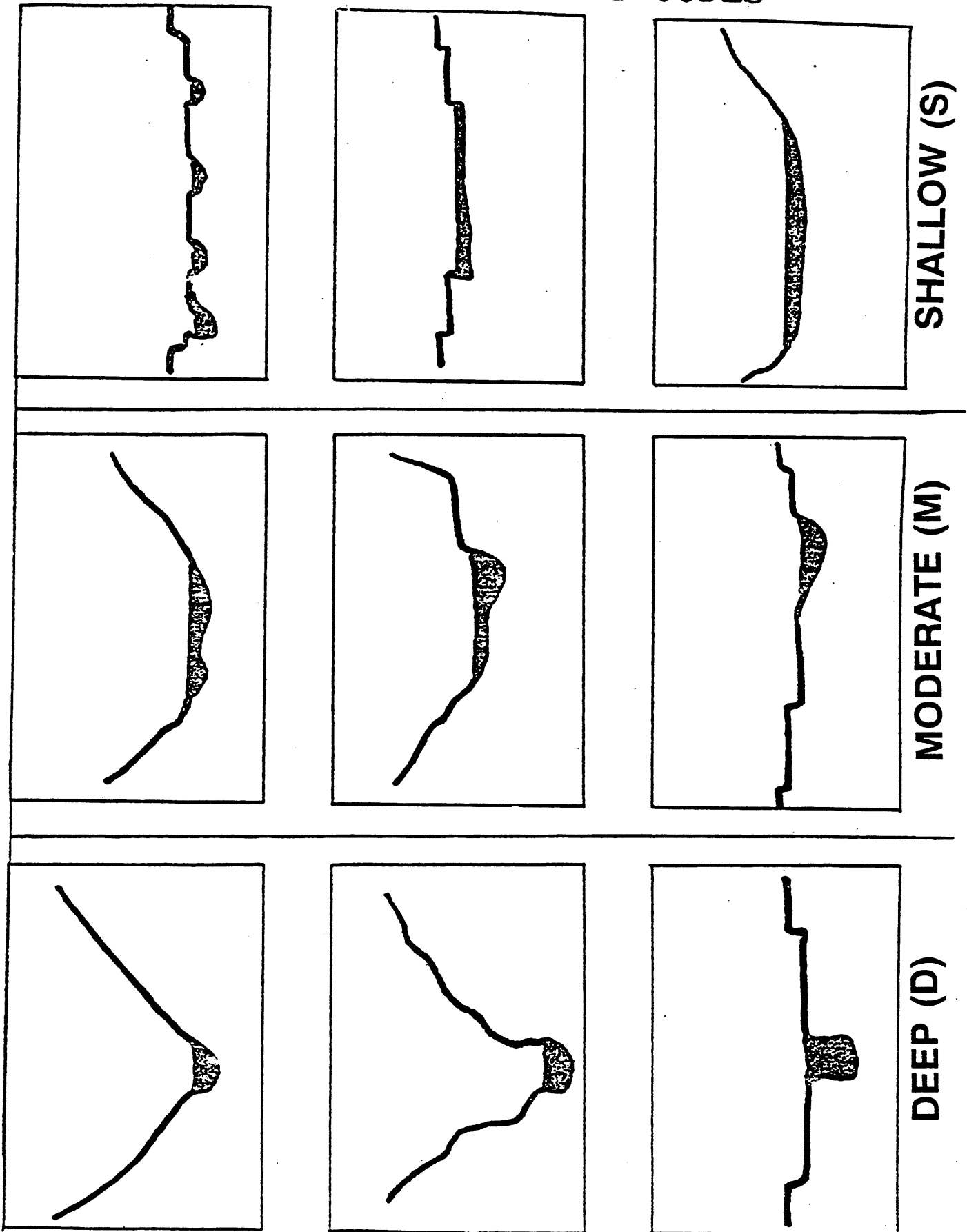
<u>Code</u>	<u>Type</u>	<u>Side Slope</u>
1 =	Box-like canyon	Steep: > 60%
2 =	Narrow V-shaped floor width < 100 ft.	Steep: > 60%
3 =	Moderate V-shaped floor width < 100 ft.	Moderate: 30-60%
4 =	Low V-shaped floor width < 100 ft.	Low: < 30%
5 =	U-shaped floor width > 100 ft.	Moderate to steep: > 30%
6 =	Through-like open short slope lengths	> 30%, mostly 30-60%
7 =	Broad, trough-like	Low: < 30%
8 =	Narrow flat-floored floor width 100-300 ft.	Moderate to steep: >30%
9 =	Moderate flat-floored floor width 300-600 ft.	Moderate to steep: >30%
10 =	Wide flat-floored floor width > 600 ft.	Moderate to steep: >30%



APPENDIX E

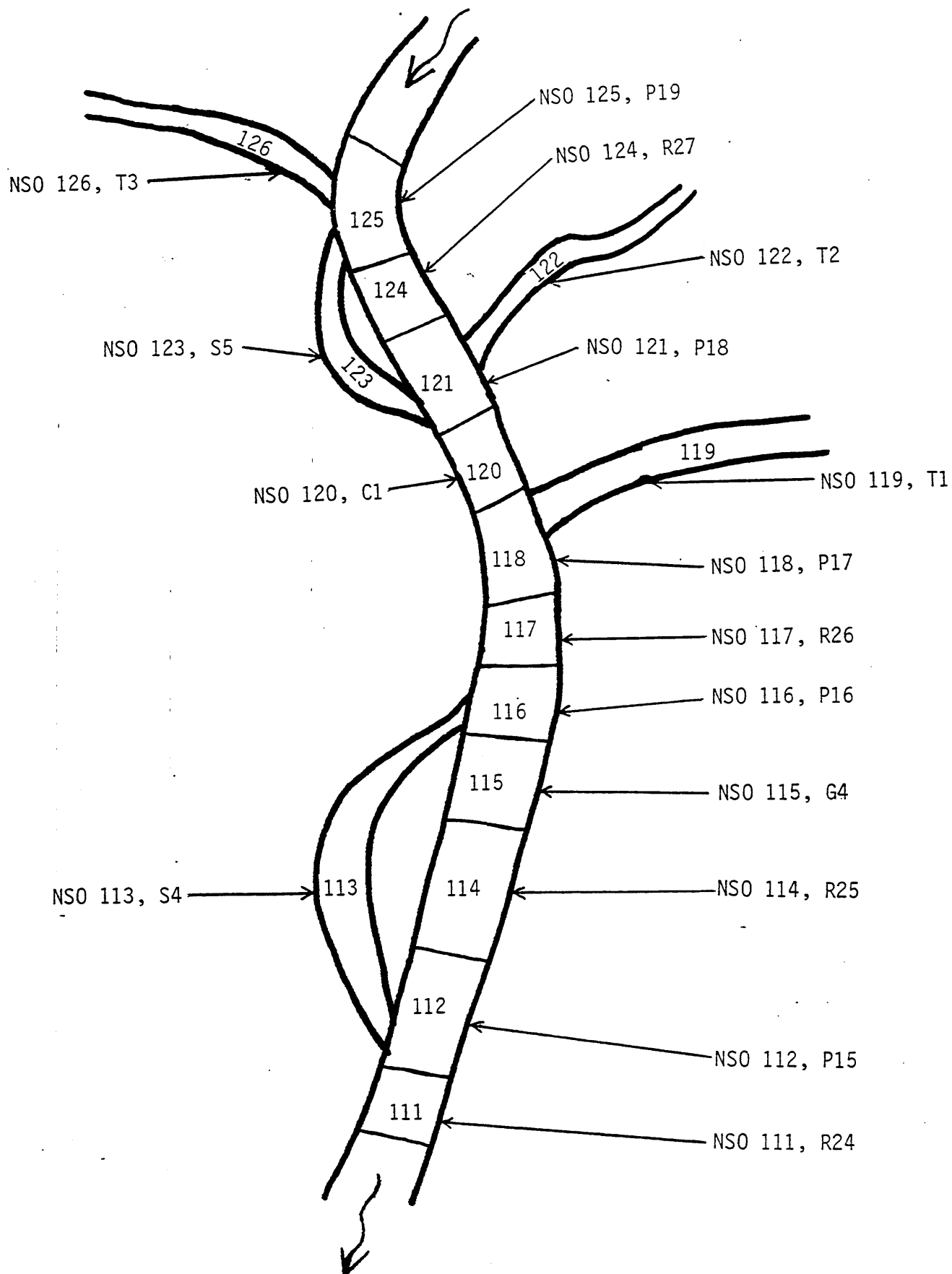
1 of 1

CHANNEL ENTRENCHMENT CODES



APPENDIX F

NSO/ Habitat Unit Numbering Conventions



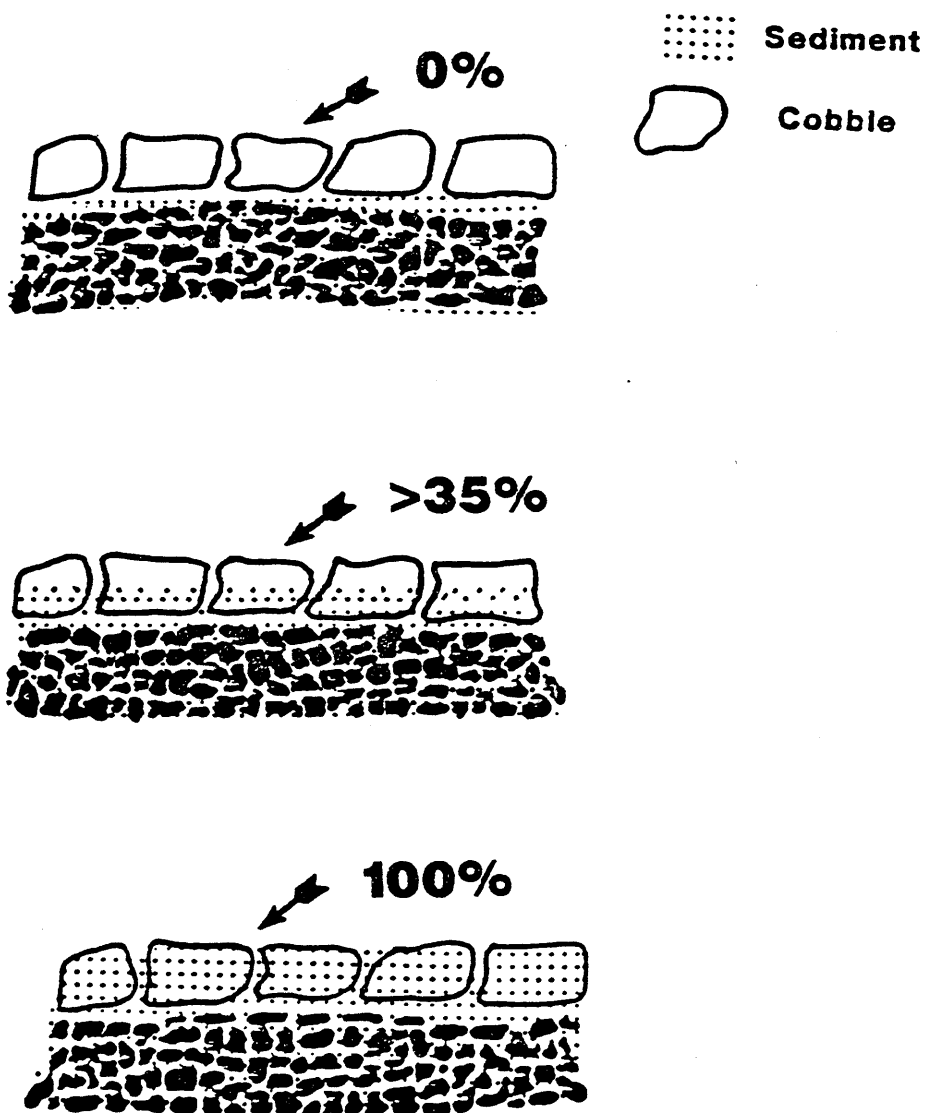
PG

53

APPENDIX G

EMBEDDEDNESS

EXAMPLE: GRAPHIC REPRESENTATION OF COBBLE EMBEDDEDNESS



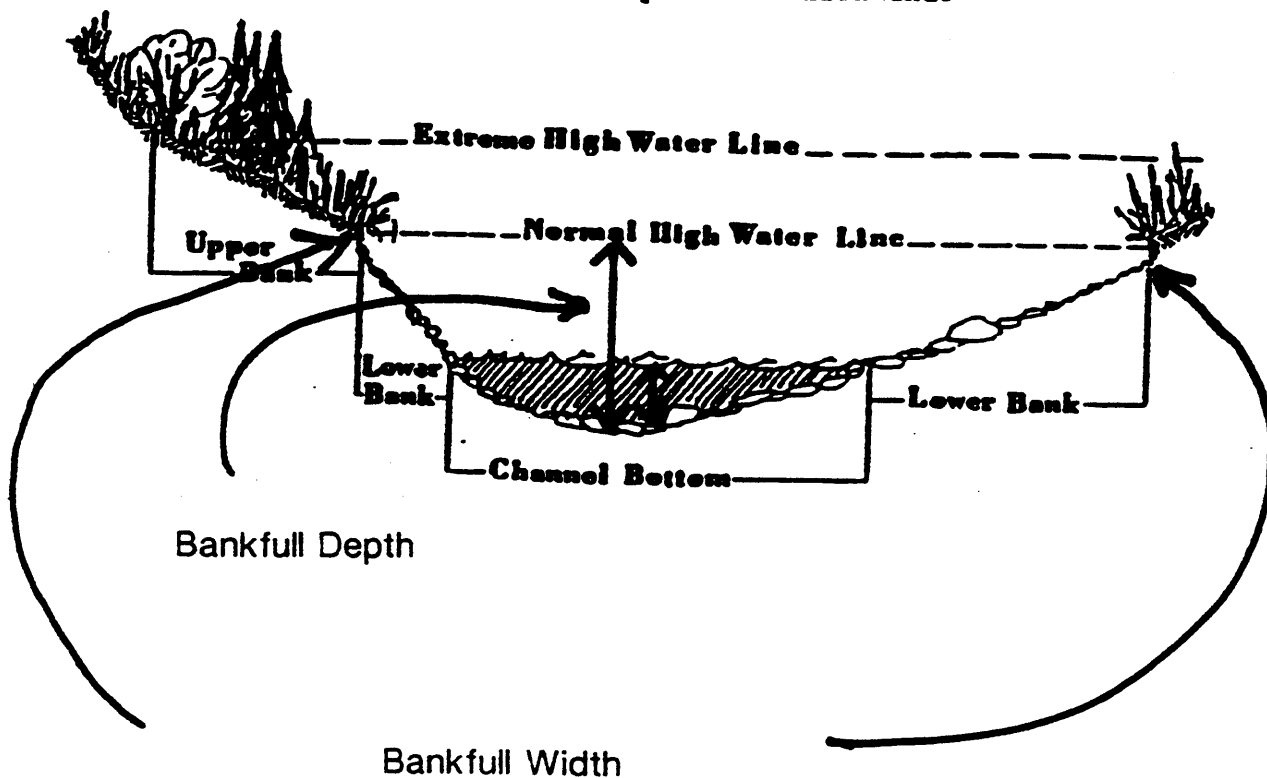
APPENDIX H

BANKFULL WIDTH / DEPTH

Upper Bank - That portion of the topographic cross section from the break in the general slope of the surrounding land to the normal high water line. Terrestrial plants and animals normally inhabit this area.

Lower Banks - The intermittently submerged portion of the channel cross section from the normal high water line to the water's edge during the summer low flow period.

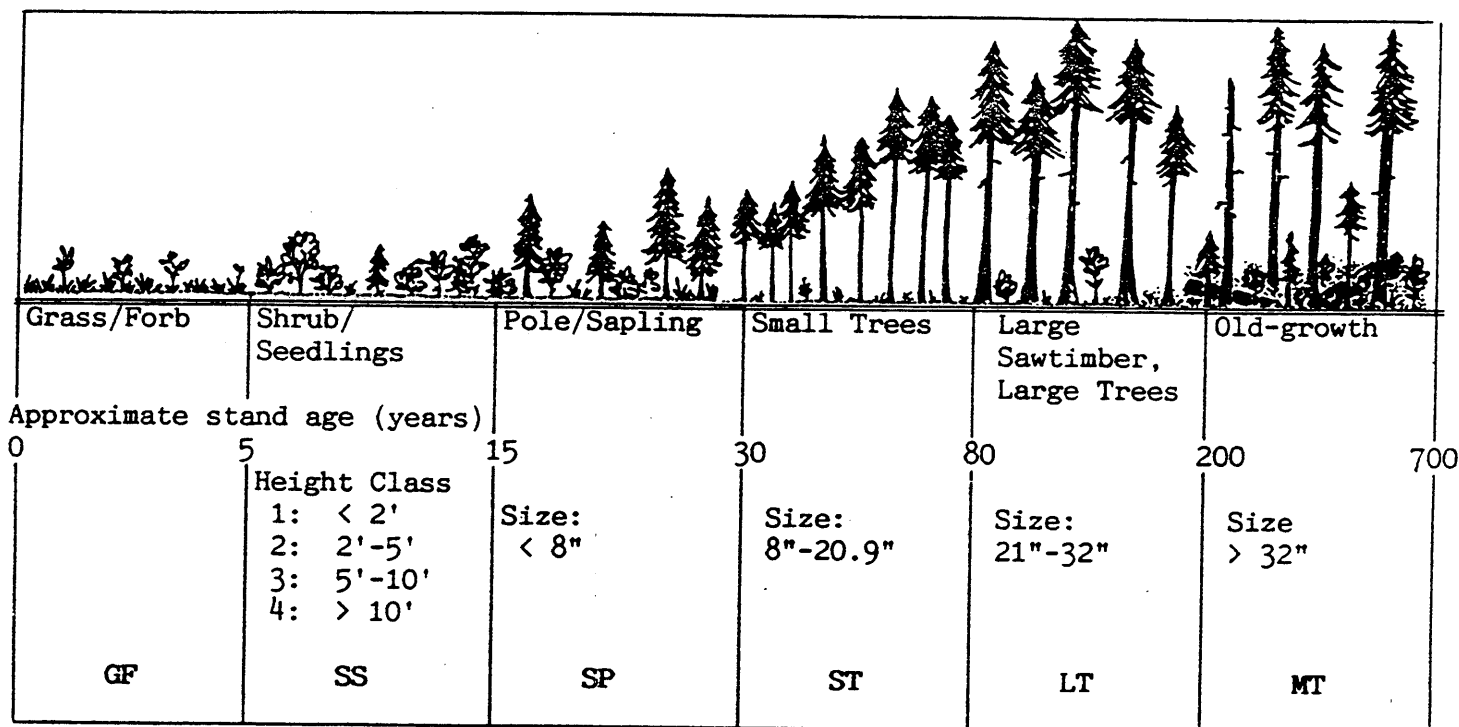
Channel Bottom - The submerged portion of the channel cross section which is totally an aquatic environment.



APPENDIX I

1 of 2

SUCCESSIONAL CLASS CODES FOR RIPARIAN VEGETATION



Code:

GF = Grass/Forb Condition:

The grass-forb stand condition lasts 2-5 years and occasionally as long as 10 years. Shrubs and some trees that sprout are not yet dominant.

SS = Shrub/Seedling Condition:

The shrub stand condition often lasts 3-10 years but may remain for 20-30 years if tree generation is delayed. Tree regeneration may be common, but trees are generally less than 10 feet tall and provide less than 30 percent of crown cover.

SP = Sapling, Pole Condition:

The open sapling-pole condition occurs when trees exceed 10 feet in height and are less than 8 inches in dbh.

ST = Small Tree Condition:

The pole condition has very little ground vegetation because of closed crown canopy. Average stand d.b.h. is 8 inches to 20.9 inches.

LT = Mature Stand Condition:

The mature condition is characterized by trees with an average d.b.h. of 21 inches to 32 inches d.b.h.

MT = Old-growth Condition:

Old-growth stand conditions are characterized by decadence of live trees, snags, down woody material, and replacement of some of the long-lived pioneer species such as Douglas-fir by climax species such as western hemlock. Stands often have two or more layers with large diameter overstory trees commonly older than 200 years. Size is generally greater than 32 inches in d.b.h.

APPENDIX J

Aquatic Habitat Inventory Glossary

Cover: Anything that provides protection from predators or ameliorates adverse conditions of streamflow and/or seasonal changes in metabolic costs. May be instream cover, turbulence, and/or overhead cover, and may be for the purposes of escape, feeding, hiding, or resting. For use in Stream Inventory, count turbulence cover as only that area of turbulence; overhead cover must be within 10 inches of the surface.

Embeddedness: The degree that larger particles (boulders, rubble, or gravel) are surrounded or covered by fine sediment.

Glide: A portion of stream flowing smoothly and gently, with moderately low velocities (10-20cm/sec), and little or no surface turbulence. The longitudinal profile of the feature will be level, or slightly sloped downstream. No hydraulic control present.

Hydraulic Control: The top of an obstruction to which stream flow must rise before passing over, or a point in the stream where the flow is constricted. Examples are bedrock outcrops, gravel bars, log weirs, or dams.

Pool: A portion of the stream which has reduced current velocity and is generally deeper than the surrounding areas. May at times contain surface turbulence, but always has a hydraulic control present across the full width of the channel on the downstream end.

Reach: A relatively homogenous section of stream having a repetitious sequence of habitat types and relatively uniform physical characteristics such as slope, depth, substrate, and bank cover.

Riffle: A portion of the stream with increased current velocity where the water flows swiftly over completely or partially submerged obstructions to produce surface agitation. For purposes of the level II survey, riffles are an inclusive term for riffles, rapids, and cascades.

Riparian Area: The area between a stream or other body of water and the adjacent upland identified by soil characteristics and distinctive vegetation. It includes wetlands and those portions of flood plains and valley bottoms that support riparian vegetation.

Riparian Vegetation: Vegetation growing on or near banks of a stream or body of water on soils that exhibit some wetness characteristics during some portion of the growing season.

Side Channel: Lateral channel with an axis of flow roughly parallel to the mainstem and which is fed by water from mainstem; a braid of river with flow appreciably lower than the main channel, or in poorly defined watercourses flowing through partially submerged gravel bars and islands along the margins of the mainstem.

Sinuosity: (a) The ratio of channel length between two points on a channel to the straight distance between the same two points. (b) The ratio of channel length to valley length. Channels with sinuosities of 1.5 or more are called meandering.

Stream Order: See accompanying Appendix B for illustration.

Stream Bank: The portion of the channel cross section that restricts lateral movement of water at normal water levels. The bank often has a gradient steeper than 45 degrees and exhibits a distinct break in slope from the stream bottom. An obvious change in substrate may be a reliable delineation of the bank.

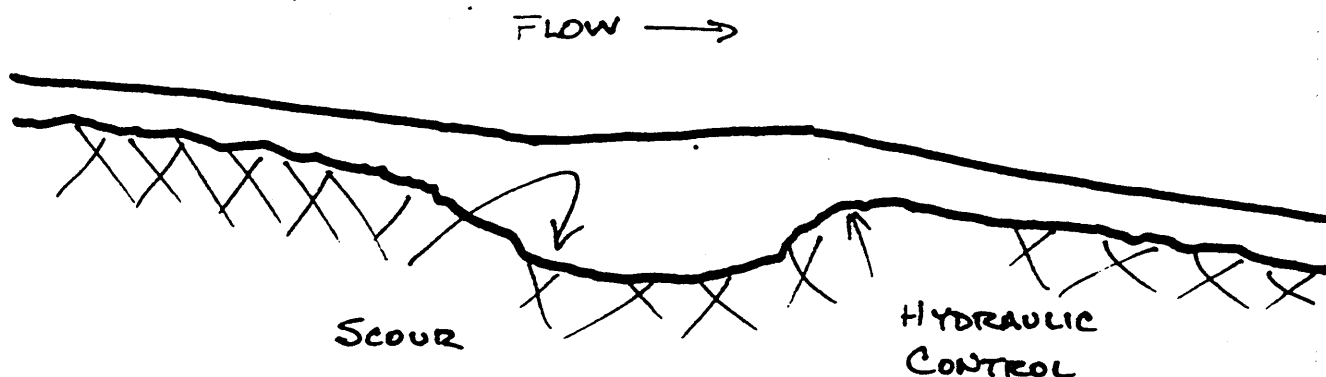
Lower Bank: The periodically submerged portion of the channel cross section from the water's edge during the summer low flow period to the normal high water line.

Upper Bank: That portion of the topographic cross section from the normal high water line to the break in the general slope of the surrounding land.

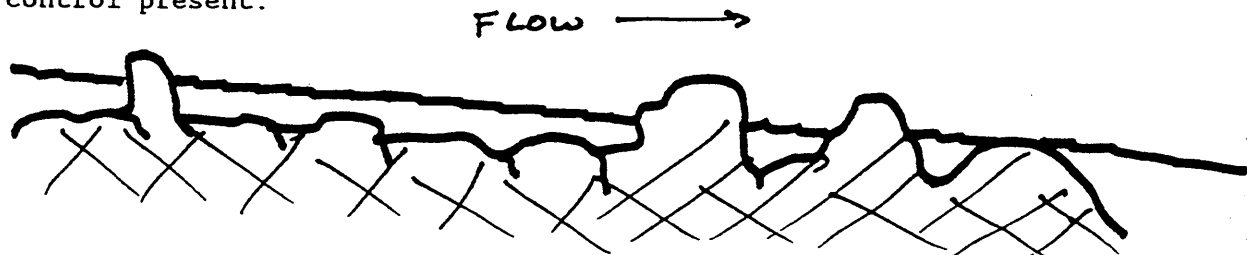
Turbulence: The motion of water where local velocities fluctuate and the direction of flow changes abruptly and frequently at any particular location, resulting in disruption of laminar flow. It causes surface disturbance and uneven surface level, and often masks subsurface areas because air bubbles are entrained in the water.

APPENDIX J

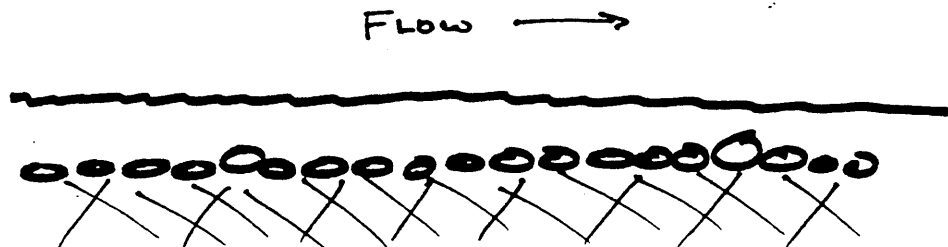
Pool: A feature of the stream generally containing reduced velocities, with water generally deeper than surrounding areas. Usually a pronounced area of scour, created by an obstruction in the channel. Always has a hydraulic control present on the downstream end of the feature across the entire width of the channel. If water flow in the channel was stopped, some water would remain in the pool.



Riffle: A feature of the stream of swift flowing turbulent water; can be either deep or shallow. Exposed substrates are generally present. Features are generally cobble or boulder dominated. No hydraulic control present.



Glide: A feature of the stream generally flowing smoothly and gently across a uniform channel bottom. Generally contains lower velocities, with little to no surface turbulence present. The longitudinal profile of the feature is generally level, or slightly sloped downstream. No hydraulic control present.



APPENDIX K

Use of Visual Methods for Estimating Fish Abundance and Habitat Areas in Small Streams¹

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¹Based on: Hankin, D.G., and G. H. Reeves. 1988. Estimating total fish abundance and total habitat area in small streams based on visual estimation methods. Can. J. Fish. Aquat. Sci. 45: in press.

APPENDIX K

I. Introduction

There is an increasing awareness among fishery biologists of the need to approach the planning and implementation of resource management programs and habitat enhancement projects from a basin-wide perspective. Biologists have generally employed one of two methods to generate a basin-wide perspective of fish production and habitat quantity: (a) extrapolation from "representative" reaches or "index" areas, or (b) systematic selection of equal length sections of stream. It has been generally assumed that either of these methods can provide accurate estimates of basin features such as total habitat areas and fish numbers.

Recent evidence has shown that use of "representative" reaches can result in generation of inaccurate and misleading notions of basin-wide conditions, however. For example, Everest et al. (1986) attempted to estimate the total amount of habitat and total fish numbers in Fish Creek, Oregon, by extrapolation from five "representative" reaches. A survey based on a statistically valid sampling design that ensures that all habitat types are sampled was carried out concurrently. Extrapolation from the "representative" reaches resulted in an apparent serious overestimation of total habitat area when compared to the statistically valid survey. Overestimation of total habitat area in turn led to overestimation of fish abundance. In another instance, Bisson (1988) estimated the number of fish in a small basin in Washington using different sets of "representative" reaches drawn from different portions of the stream. He found that estimated numbers of fish varied by several orders of magnitude depending on choice of "representative" reaches.

In this paper we present cost-effective sampling designs for estimating total habitat areas and total fish numbers in small streams based on visual estimation (Hankin and Reeves 1988). We consider practical application of these sampling designs in the field, and we also discuss procedures for construction of confidence intervals around calculated estimates. In addition to providing estimates of total habitat areas and fish abundance, use of these sampling designs can produce detailed maps showing the size, sequence of occurrence, and location of all stream habitat units. Data generated using these procedures may be used for identification of limiting factors and for inventory and monitoring purposes.

II. Estimating Total Habitat Area

A. Classification of habitat units

This sampling design places substantial reliance on visual estimation of the areas of identifiable habitat units. The first step in implementation of this design is therefore determination of what habitat unit types area of interest. We suggest use of definitions from Bisson et al. (1981) or those in the "Glossary of Stream Habitat Terms" (Habitat Inventory Committee, Western Division of the American Fisheries Society 1985). Consistent definitions and criteria for classification of habitat unit types are vital to the success of a stream survey. Without such consistency, for example, it would be impossible to compare data collected by different observers in the same stream. Standardized definitions also allow comparison of habitat characteristics between streams.

APPENDIX K

Determination of the particular types of habitat units that are to be identified will depend on the purpose of a survey. Monitoring efforts usually require a more detailed classification of habitat unit types than general inventories. For basic inventory purposes it may be adequate to classify habitat types into very general categories such as pools and riffles. For detailed monitoring purposes, however, it may be necessary to define additional categories such as glides, side channels, and special types of pool units (e.g. break, lateral scour and plunge pools). Monitoring of enhancement efforts may be directed at a specific habitat type that is to be created. Regardless of the purpose of a survey, the types of habitat types that are of interest must be identified before the survey is initiated.

Prior to field work, all habitat characteristics that are to be measured should be identified. As for selection of habitat unit types, additional habitat characteristics to be measured will depend on survey purpose. The sampling design we describe below allows collection of a large amount of data at individual habitat units. Data generally collected included length, mean unit width, maximum unit depth, number of pieces of wood in given size categories, and dominant substrate.

B. Measurements at each unit

Two people are required for data collection for this method. One person (the "observer") is responsible for actual data collection whereas the other is responsible for data recording (the "recorder"). All visual or "eye" estimates described below should be made only by the observer.

The observer begins at the first habitat unit in a stream, identifies its habitat unit types, and then visually estimates its length, mean width, and area (length x mean width). Other habitat characteristics may also be measured or estimated. Points of reference, such as tributary junctions, road crossings, etc., should be noted by the recorder so that location in the basin can be better identified when the survey is completed.

As for definition of habitat units types, it is imperative that standardized criteria are followed for all measurements, visual or other. For example, it is often difficult to judge an appropriate length measurement for a pool that is irregularly shaped at one end. We have adopted the rule that the "end" of the pool is the midpoint between the point at which the pool becomes irregular in shape and the irregular end point of the pool.

APPENDIX K

In a systematic sample of units within a given habitat type, accurate measurements of unit characteristics are made in addition to visual estimates.

For example, suppose one wanted to obtain accurate measurements of area in 10% of all pools in some reach of a stream (i.e. a sampling fraction of 10% is desired). The first unit to be measured should be determined by drawing a random number between 1 and 10 and making an accurate measurement of pool area in the pool that is selected. Then, accurate measurements of pool area should be made in every tenth pool thereafter. The initial "random start" might be 7, for example, in which case accurate measurements of pool area would be made in pool units 7, 17, 27, etc..

Selection of valid systematic samples for accurate measurements of habitat unit characteristics requires attention to two details. First, independent random starts should be drawn for each different classified habitat unit type. Second, once the initial random start has been selected for a given habitat unit type, then all subsequent accurate measurements must be made at exactly the same (systematic) interval between units. For example, suppose that the initial random start were 7 and that every tenth pool unit thereafter was to be accurately measured, as above. If field work on day "one" ended at pool unit 44, then the first pool unit for accurate measurements on day "two" should be pool unit 47, and subsequent units would be 57, 67, etc..

Accurate measurements of habitat unit areas should be made according to the following procedure: (a) measure unit widths at fixed 1-2 m intervals along the length of the unit and calculate the mean of these width measurements; (b) multiply mean width by total unit length to determine habitat unit area. Note that choice of interval between width measurements should depend on the complexity of a given habitat unit. A 2 m fixed interval may provide an accurate measurement of mean width in a broad, flat, straight riffle unit, whereas a 1 m interval may be required for accurate measurement of mead width in a complex, irregularly shaped pool unit.

If subsequent estimation of fish abundance is also to be carried out in the survey, the individuals responsible for collecting physical data should also mark and identify those units that will later be sampled for fish. The procedure for selection of units for fish sampling is described in part III of this paper. Both the lower and upper boundaries of these units should be marked with highly visible plastic flagging that has the unit type and unit number marked on it.

C. Data entry and storage

Use of this sampling design generally results in generation of large amounts of survey data. It is simplest to enter, store, and manipulate data in a computer spreadsheet such as LOTUS. [A spreadsheet will soon be available in DG (Data General) system for U.S. Forest Service biologists.] Data for individual habitat units should be entered on the computer in the same order in which units were encountered in the field survey (e.g., pool 1, glide 1, riffle 1 pool 2, glide 2, etc.). This procedure will retain the natural habitat unit location sequence for later mapping purposes, and the spreadsheet will allow easy sorting by habitat unit type regardless of order of data input. Most data manipulations and calculations association with use of this sampling design can generally be carried out within the spreadsheet format.

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D. Calculations and formulas

The basic premise of this method is that if visual estimates of habitat unit areas are highly correlated with accurate estimates of habitat unit areas, then one can "correct" for the possible bias of visual estimates through calculation of a "calibration ratio". The calibration ratio represents an estimate of the true ratio of true habitat unit area as compared to visually estimated area. This calibration ratio is calculated based on n paired visual and accurate estimates made in selected habitat units using

$$(1) \text{ Calibration ratio} = \hat{Q} = \sum m_i / \sum x_i$$

where m_i = true (accurately measured) area of unit i ;
 x_i = visual estimate of area of unit i ; $i = 1, 2, \dots, n$

Q is an estimator of the true (but unknown) ratio of the actual area of all units compared to corresponding visual estimates of the areas of all units. (The carat or "hat" over Q is used to indicate an estimated quantity.) Calibration ratios should be calculated on the basis of *no less than 10* (i.e. $n \geq 10$) paired accurate measurements and visual estimates *for each habitat unit type*. That is, separate calibration ratios must be calculated for pools, riffles or other habitat unit types. Note that the number of paired accurate measurements and visual estimates for a given habitat type will depend on (a) the total number of units of that type, and (b) the sampling fraction for that habitat unit type. If a particular unit type is quite rare, a much larger sampling fraction will be required to achieve the minimum sample size of 10 units than if a particular habitat unit type is quite common.

Visual estimates of habitat unit areas do not necessarily need to be "close to" the true (accurate measurement of) habitat unit areas, but it is important that visual estimates have a *consistent* relationship to true habitat unit areas. For example, if all visual estimates were exactly half of true areas, then it would be a simple (and accurate) matter to adjust all visual estimates by a calibration ratio of 2 to arrive at very accurate estimates of habitat unit areas.

It is advisable to plot the relationship between accurate measurements of habitat unit areas and corresponding visual estimates of areas in addition to calculating the calibration ratio.

Visual inspection of plotted data points may reveal outliers or coding errors that might not be otherwise noticed. Also, it is a good idea to check that the plotted data appear to pass through the origin. If plotted data do not appear to pass through the origin, then the formulas presented below may be seriously biased. (Alternative regression estimators should be used in that case, but they are not presented in this paper.)

Once the calibration ratio has been calculated and plotted data have been visually inspected, the total area of habitat for a given habitat unit type (M) can be estimated using

$$(2) \quad \hat{M} = T_x \hat{Q}$$

where M = true total area of all units of a given type;

$T_x = \sum x_i$ = total of visual estimates of area for *all* units of a given type;

N = total number of units of a given habitat type

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Equation (2) is a very natural and intuitive estimator, usually called a 'ratio estimator.' Equation (2) states that the true total habitat area can be estimated as the product of (a) the total of the visual estimates and (b) the estimated ratio of true area to visual estimates of area.

A measure of the uncertainty of the estimated total area of a particular habitat type can be calculated from sample data using an estimator for the variance of equation (2). The variance of the estimated total, denoted by $V(\hat{M})$, can be estimated using

$$(3) \quad \hat{V}(\hat{M}) \approx \frac{N^2(N-n)}{Nn} \sum_{i=1}^n (m_i - \hat{Q}x_i)^2 / (n-1)$$

Equation (3) is a large sample approximation for the variance of a ratio estimator and it may seriously underestimate the uncertainty of the estimated total habitat area if $n < 10$. For that reason, we recommend that $n > 10$.

Examination of equation (3) reveals that variance depends on two very different kinds of terms. First, variance (uncertainty) will be reduced simply as a function of sample size through the terms $(N-n)/Nn$. As sample size, n , approaches the total number of units, N , clearly variance approaches zero. Thus, the sampling fraction (n/N) will influence variance. Second, the summation term essentially consists of squared differences between (a) true (accurate measurements of) habitat unit areas, m_i , and (b) predicted habitat unit areas, $\hat{Q}x_i$. If accurate estimates and visual estimates are highly correlated, and a plot of accurate estimates against visual estimates appears to pass through the origin, then these squared differences will be small so that estimated variance will be small. In contrast, if visual estimates are inconsistently related to accurate measurements, then predictions of true habitat areas from visual estimates will be poor, square differences will be large, and estimated variance will be large.

The strong dependence of estimator variance on a consistent relationship between true habitat unit areas and visual estimates of habitat areas makes it especially critical that observers follow a consistent technique in making their visual estimates. Careful pacing off units at approximately 5 m increments requires substantial concentration and we recommend that our observers take periodic breaks to relax rather than making poor or inconsistent visual estimates of habitat areas. This requirement for consistency is also behind our recommendation that just a single observer be responsible for all visual estimates.

The total area of all units of all identified habitat types in a stream can be estimated simply by summing up individual estimates for individual habitat types (or individual habitat types within a particular reach of stream). Estimated variances are also additive because estimate of total habitat areas of particular habitat unit types are independent of one another (since they are based on entirely separate sample data).

Finally, approximately 95% confidence intervals for estimated total areas of habitat units can be constructed as

$$\hat{M} \pm 2 \cdot [\hat{V}(\hat{M})]^{0.5}$$

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Table 1 presents results of application of this sampling design in a small Oregon coastal stream, Cummins Creek. In the Cummins Creek application, the stream was first stratified into a lower and a middle/upper reach. Sampling fractions were 10% (1 out of 10) in the lower reach and 5% (1 out of 20) in the middle/upper reach. Use of this method in Cummins Creek produced 95% confidence bounds for estimated total areas of pools and riffles that were about 13% and 16% of estimated totals, respectively.

E. Maps of habitat unit locations and sizes

Besides providing estimates of the total areas of particular habitat unit types, often with very small confidence intervals, this sampling design allows the construction of detailed maps of the locations and areas of all habitat units. Such maps could be used to compare habitat unit areas and sequence between seasons or years, or to evaluate the effects of various habitat alterations.

F. Costs

We estimate that it costs from \$80 - \$100 per mile to survey small basins using this technique. This cost estimate includes costs of (a) data collection, (b) computer data entry, and (c) data analysis. The cost will of course vary with crew experience, basin size, and the number of habitat unit types identified. In most systems, an experienced crew can cover 4-6 stream miles per day. Interestingly, larger systems may often be covered more quickly than smaller systems because habitat units are larger so that there are fewer per stream mile. Finally, the general requirement that sample sizes exceed 10 for each distinct habitat unit type means that large numbers of distinct habitat unit types will require a large number of accurate (and more costly) measurements of habitat areas.

Table 1. Total number of units (N), number of units accurately measured (n), sample-based estimates of ratios of accurately measured areas to visually estimated areas (\hat{Q}), estimated total areas (\hat{M}), estimated total areas ($\hat{V}(\hat{M})$), and 95% confidence bounds for estimated total areas (95% C.I.) for pools and riffles in lower, middle/upper, and all reaches combined of Cummins Creek during July 1985. Visual estimates of habitat unit areas were made for all units. (from: Hankin and Reeves, 1988)

Pools

Reach	N	n	\hat{Q}	\hat{M}	$\hat{V}(\hat{M})$	95% C.I.
Lower	65	7	0.990	6,141	119,827	± 875
Middle/ Upper	134	6	1.029	8,284	448,315	$\pm 1,721$
All Reaches				14,425	568,142	$\pm 1,938$

Riffles

Lower	62	6	1.066	12,556	159,155	$\pm 1,026$
Middle/ Upper	124	7	0.926	19,208	3,846,554	$\pm 4,799$
All Reaches				31,764	4,005,709	$\pm 5,146$

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G. Review of Procedures (* denotes optional procedure)

(1) Prior to field work:

- a. Determine the types of habitat units that are to be identified.
- b. Determine habitat unit characteristics that are to be measured or estimated at each unit.
- c. Determine sampling fractions ($1/k$) for each habitat unit type (this will determine the number of units for which both accurate and visual estimates of habitat unit area are made).
- d. Given prespecified values for k , which may differ between habitat unit types, choose independent random starts on the interval 1 through k for *each distinct habitat unit type*.
- *e. If necessary or desirable, stratify basin into different areas or reaches on the basis of stream gradient or other distinctive feature(s). These different areas or reaches will constitute distinct location strata and should each be independently sampled.

(2) Field work:

- a. Observer begins at first habitat unit, identifies its type, and collects necessary data. Observer makes visual estimate of habitat unit area for *every* identified habitat unit. Points of reference are noted by data recorder.
- b. At the unit selected by the random start within each identified habitat type, and at every k units thereafter, the observer makes a visual estimate of habitat unit area, and the two person team makes an accurate estimate of habitat unit area.
- *c. If necessary, observer marks units which are to be later sampled for fish. Units should be marked with highly visible flagging at the upstream and downstream ends of these units and flagging should have unit type and unit number written on it.

(3) Data entry and analysis:

- a. Data are entered into spreadsheet in the natural order in which units were encountered in field work.
- b. Distinct calibration ratios are calculated for each identified habitat unit type using equation (1).
- c. Total areas, associated variances and confidence intervals are calculated for each identified habitat unit type using equations (2) and (3).

III. Estimating the total number of fish

A. Selection of units

It is obviously impractical to estimate the total number of fish by sampling every stream habitat unit. Instead, we recommend selection of a systematic sample of habitat units (from within each habitat type), following those procedures presented for selection of units for accurate measurements in part II.B. Systematic selection of units does not require a preexisting map of the locations of all habitat units nor does it require knowledge of the total number of units of each habitat type. In addition, systematic samples will ensure that sample data are collected along the entire longitudinal gradient of the basin. As for units selected for accurate measurements of habitat areas, sampling within each distinct habitat unit type must begin with an *independent* random start.

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The fraction of the units that are sampled need not be the same for every habitat type and may depend on unit type, fish species and habitat preferences as well as available time, funds and personnel. It is usually, but not always, best to have higher sampling fractions for those habitat types that appear to be preferred by the species of interest. For example, if the species of interest were 1+ juvenile steelhead trout or coho salmon, then pools should probably have a higher sampling fraction than riffles or glides. In this case one might sample 25% of all pools, 15% of all glides and just 10% of all riffles. It is extremely important to remember that all habitat unit types must be sampled even if fish are not "believed" present in some habitat types. There is only one method by which their absence in that habitat type may be verified: collection of sample data for that habitat type.

Units which are to be sampled for fish should have been previously marked by the two person team responsible for physical habitat measurements. Plastic flagging or other markers with unit type and number should have been placed at the upper and lower boundaries of selected units. If visual counts of fish are to be made by divers in selected units, then it is best to have a minimum of two hours between the time the units are marked and they are actually snorkled. This delay should be sufficient to minimize any effects of disturbance on fish in habitat units.

B. Sampling fish populations

Estimation of fish numbers relies on essentially the same premise as estimation of habitat areas. If divers count a fairly consistent fraction of fish actually present in habitat units, then there should be a strong correlation between diver counts and the "true" (accurate estimates of) numbers of fish present. In this case visual estimates are made by divers using mark and snorkel and "accurate" estimates are made using a multiple pass electrofishing removal method estimator. By calculating a calibration ratio relating these accurate estimates to diver counts, based on a small sample of units in which both visual estimates and accurate estimates are made, one may "adjust" diver counts to estimates of true abundance in those units in which only visual estimates are made.

A team of two divers is used to count fish. Divers enter the water downstream from the selected unit and proceed slowly upstream. The divers position themselves near the midline of the unit and move parallel to one another using hand signals to coordinate their movements. Observed fish are identified to species or species/age class and counted. Fish counts are recorded with a lead pencil on a plexiglass slate that has had the surface roughened with sandpaper. Observations should all be made during times of day when visibility is best, generally between 0900 and 1700.

Correlations between diver counts and accurate estimates will generally vary with species, age-class and habitat type. For example, we found higher correlations between diver counts and accurate estimates for coho salmon in pools than for 1+ steelhead trout in pools (Hankin and Reeves 1988). These differences were attributable to differences between the two species in microhabitat distribution and behavioral responses to divers. Trout were closely associated with the bottom, whereas coho salmon were more surface-oriented and were thus easier to see. Trout were also more "skitterish" and sought cover more quickly than salmon, especially in smaller units. Because of these differences, divers scanned the bottom immediately upon entering units and counted trout *before* salmon.

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Use of snorkeling to count fish has obvious limitations which may make it impractical for use in some situations. Water clarity is critical, the method is most effective in small streams, and there are generally limited numbers of individuals who are highly trained and skilled in this method of observation. We are currently exploring alternatives to snorkeling, but we have not yet developed any sound alternatives.

Of those units in which diver counts of fish numbers are made, we select a random *subsample* within which both diver counts and more accurate estimates are made. The theory of this method requires that the "accurate" estimates of fish abundance be equal to the "true" but unknown numbers of fish present. It is therefore extremely important that accurate methods produce estimates of fish numbers that have very small confidence intervals.

C. Data entry and storage

Data on diver counts and accurate estimates made for selected units can be entered in the spreadsheet format in the same manner as those for physical habitat measurements. Additional computer programs may be necessary for estimation of population size for the "accurate" estimation method, however.

D. Calculations and formulas

A "calibration ratio" establishing the correspondence between accurate estimates (true numbers) of fish present, y_j , and diver counts, d_j , within a given habitat type may be calculated using

$$(4) \hat{R} = \left(\sum_{j=1}^{n'} y_j \right) \left(\sum_{j=1}^{n'} d_j \right)$$

where: Y_j = true number of fish in unit j ; $j = 1, 2, \dots, n'$
 (estimated by use of every accurate method);
 d_j = mean count of fish by two divers in unit j ;

n' = number of units in which both diver counts and accurate estimates are made.

As for estimation of habitat areas, distinct calibration ratios must be calculated for each habitat type and there should be a minimum of ten units within each habitat type for which both diver counts and accurate estimates are made (i.e. $n' \geq 10$).

Ideally, the units selected for accurate estimates in addition to diver counts should be a simple random or systematic subsample of those units in which diver counts are made. Occasionally, however, it may prove impractical or impossible to carry electrofishing equipment into some selected units. In that event, units reflecting the full range of size and complexity of those units found in the system should be included in the sample of size n' .

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For units in which only diver counts have been made, the calculated "calibration ratio" allow adjustment of diver counts to give a better estimate of the true number of fish actually present. (Divers may only count half the fish that are actually present, for example, in which case the true calibration ratio would be 2.) The numbers of fish present in such units can therefore be estimated as the product of the mean diver count and the estimated calibration ratio using

$$(5) \quad \hat{Y}_i = \hat{R} d_i$$

where: \hat{R} = calculated calibration ration (equation (4));
 d_i = mean of two diver counts in unit i.

If the total number of units in which diver counts are made is defined as n, and the total number of units in which both diver counts and accurate estimates are made is defined as n', then there will in general be (n-n') units in which fish numbers will be estimated using equation (5). In the remaining n' units, the "accurate" method of estimating fish numbers eliminates the need to use equation (5); the accurate estimates should be used for these units.

Finally, the total number of fish present in all units of a given habitat type may be estimated using

$$(6) \quad \hat{Y} = N \sum_{i=1}^n \hat{y}_i / n$$

where: Y = (true) total number of fish in all units of a given habitat type;
 N = total number of units of a given habitat type;
 n = total number of units in which diver counts are made; i = 1, 2, ..., n.

Equation (6) is simple and intuitive. It basically consists of multiplying the mean estimated number of fish per habitat unit (= $\sum \hat{y}_i / n$) by the total number of habitat units (= N).

In some streams, the number of fish present in habitat units may be highly correlated with the sizes of habitat units. In that case, equation (6) will not give the best estimate of total fish abundance. Hankin (1984, 1986) discusses alternative estimators that will perform better than equation (6) if fish numbers are highly correlated with habitat unit sizes.

A measure of uncertainty for the estimated total number of fish in a given habitat type may be calculated using the following estimator for the variance of equation (6):

$$(7) \quad \hat{V}(\hat{Y}) = \frac{N(N-n)}{n(n-1)} \sum_{i=1}^n (\hat{Y}_i - \bar{y})^2 + \frac{N}{n} \sum_{i=1}^n \hat{V}(\hat{Y}_i)$$

where: N = total number of units of a given habitat type
 n = total number of units in which diver counts are made
 y_i = estimated number of fish in unit i; i = 1, 2, ..., n
 $\bar{y} = \sum y_i / n$ = mean estimated number of fish per habitat unit.
 and $V(y_i)$ = estimated variance of the estimated number of fish in unit i.

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$\hat{V}(\hat{y}_i)$ represents errors of estimation of fish numbers in individual habitat units. It may be assumed equal to zero for those units in which very accurate estimates are made or, alternatively, may be calculated on the basis of formulas appropriate for removal method estimation using electrofishing. (Remember that there are n' out of n units in which the accurate estimates have been made.)

For those units in which *only* diver counts are made (there are $n-n'$ such units), $\hat{V}(\hat{y}_i)$ will depend on (a) variation between the two diver counts made in those units and (b) variance of the estimated calibration ratio relating accurate estimates to diver counts.

Between diver variance is denoted by $\hat{V}(d_i)$ and is estimated using

$$(8) \quad \hat{V}(d_i) = 1/2 \sum_{k=1}^2 (d_k - d_i)^2$$

where: d_k = count of fish by diver k in unit i ; $k = 1, 2$

$$d_i = \sum_{k=1}^2 d_k / 2 = \text{mean diver count in unit } i$$

i = unit in n but *not* in n'

Variance of the estimated calibration ratio is calculated using

$$(9) \quad \hat{V}(\hat{R}) = \frac{(N-n')}{Nn' \bar{d}^2} \sum_{i=1}^{n'} (\hat{y}_i - R d_i)^2 / (n'-1)$$

where: $\bar{d} = \sum_{i=1}^{n'} d_i / n' = \text{"grand mean" diver count}$

Note that the summation in equation (10) is over the n' units for which *paired* diver counts and accurate estimates were made.

Finally, for those $(n-n')$ units in which only diver counts have been made, variance of the estimated number of fish in such units can be calculated using

$$(10) \quad \hat{V}(\hat{Y}_i) = \hat{R}^2 \hat{V}(d_i) + (d_i \hat{V}(\hat{R}) - \hat{V}(d_i) \hat{V}(\hat{R}))$$

These values would then be substituted in equation (7), above.

Although of complicated forms, the above formulas for calculating the variance of an estimated total number of fish in a given habitat type can be separated into two distinct parts. One component of variance arises due to what statisticians term *first stage variance*. If there were no errors of estimation of fish numbers within selected habitat units, but only a sample of n habitat units were selected from a total of N habitat units, there would be errors of *extrapolation* from the sample units to all of the units. These errors result from variation in the true numbers of fish *between* habitat units. If, for example, each unit had exactly the same number of fish, then there would be no variation in fish numbers between units and, as a result, first stage variance would equal zero. In contrast, if true fish numbers were highly variable across habitat units, then first stage variance would be large.

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Most fishery biologists are not very familiar with the concept of first stage variance, but they are very familiar with what statisticians term *second stage variance*. Second stage variance reflects errors of estimation of fish numbers *within* selected units. If every habitat unit were sampled, then all of the errors of estimation would come from this stage of sampling since no extrapolation would be involved. Mark-recapture or removal method estimators of population size will in general result in smaller second stage variance than "calibration" of diver counts.

In our experience with sampling streams, first stage variance usually is a much more important source of error of estimation than is second stage variance. Also, if numbers of fish present in habitat units are poorly correlated with the sizes of habitat units, then first stage variance can only be reduced by sampling a large fraction of all habitat units. The use of divers for visual estimates of fish numbers in habitat units allows one to greatly increase the total number of units that are sampled for fish. Although this usually results in slightly greater errors of estimation of fish numbers *within* units (second stage variance), the substantial reduction in first stage variance that results more than compensates for these minor additional errors. To put it more simply, one makes a modest sacrifice of accuracy within *individual* habitat units to obtain a dramatic increase in accuracy of estimation of fish numbers in *all* habitat units.

Table 2 illustrates the results of applying these methods for estimation of juvenile coho salmon and 1+ steelhead trout numbers in pools and riffles of Cummins Creek. Diver counts were made in approximately 20% of all units and paired diver counts and exhaustive electrofishing/removal method estimates were made in about 8 units of each habitat type. Confidence bounds (not reported on Table 2) for the total abundance of salmon and trout in all pool and riffle units combined were approximately 22% and 17% of the estimated totals, respectively.

Table 2: Estimated abundances (\bar{Y}) of 1+ steelhead trout and juvenile coho salmon, total number of habitat units (N), sample sizes for diver counts (n), and estimated variances of abundance estimates ($V(\bar{Y})$) in lower, middle and upper pools and riffles and in all pools, all riffles and all pools and riffles, in Cummins Creek, July 1985. (from: Hankin and Reeves 1988.)

<u>Habitat Type/ Location Stratum</u>	N	n	<u>Coho Salmon</u>		<u>Steelhead Trout</u>	
			\hat{Y}	$\hat{V}(\hat{Y})$	\hat{Y}	$\hat{V}(\hat{Y})$
Lower pools	65	11	2,111	112,769	1,480	21,185
Middle pools	67	13	1,088	36,024	738	17,205
Upper pools	67	12	101	1,266	428	13,943
All pools			3,300	150,059	2,646	52,333
Lower riffles	62	10	576	40,407	527	24,505
Middle riffles	67	13	230	5,588	236	4,967
Upper riffles	57	9	0	0	0	0
All riffles			806	45,995	763	29,472
All pools and all riffles			4,106	196,054	3,409	81,805

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E. Costs

We have not determined the average costs of sampling fish populations using this sampling design. However, we have compared the probable performance of this design with a more typical stream survey that might be carried out exclusively using electrofishing methods for estimation of fish numbers in selected habitat units (Hankin and Reeves 1988). For the same total cost of sampling, we found that our visual estimation survey (with calibration) would result in variances that were from 1.7 to 3.3 times *smaller* than those that would be achieved in the more standard survey (electrofishing only). That is, for the same total survey cost, the visual estimation design was from 1.7 to 3.3 times as *cost-effective*. For the typical survey, fewer units can be sampled if only electrofishing is used to estimate fish numbers in selected habitat units. Although diver counts may be less accurate than electrofishing, divers can count fish much more rapidly and can therefore examine a much larger number of habitat units. This increased coverage of habitat units in turn leads to a substantial reduction in first stage variance and in total errors of estimation.

F. Review of procedures (*denotes optional procedure)

(1) Before field work:

- a. Determine types of habitat units that are to be identified.
- b. Determine sampling fractions for visual estimates of fish numbers for each habitat unit type. (These may differ with habitat unit type.) Select independent random starts for each habitat unit type. Units selected by these random starts should be marked by the team collecting physical data (Part II) as should subsequent units that appear in systematic samples drawn from each habitat type.
- c. Determine approximate subsampling fraction for which *both* visual estimates and accurate estimates will be made. Select appropriate random starts for selection of these units from those selected and marked in (1)b.
- *d. If necessary or desirable, stratify basin into different areas of reaches on the basis of gradient changes or other distinctive features.

(2) Field work

- a. Divers proceed to unit selected as random start for each habitat type and count fish numbers in that unit and in subsequent units that appear in systematic samples. Record unit numbers and fish counts (individually) on data sheets as appropriate.
- b. For units selected in (1)c above, use a multiple pass electrofishing removal method estimator to obtain an accurate estimate of true fish numbers in these units. (Diver counts are *also* made in these units).

(3) Data entry and analysis

- a. Enter collected data in spreadsheet as for physical habitat data.
- b. Calculate calibration ratios for each distinct habitat unit type, using equation (4).
- c. Estimate true numbers of fish present in those units for which only diver counts are available using equation (5).
- d. Estimate the total number of fish in all units of a given habitat type using equation (6).
- e. Calculate variance estimates using equation (7) - (10).

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A. State _____ B. County _____ C. Forest _____ D. District _____

F. Watershed Code _____ NFS _____; _____, _____, _____, _____

H. Survey Date: ____/____/____
Year/ Month /Day

I. Name: _____

1. Watershed Area _____ Acres (Hectares)
2. Stream Order _____
3. Stream Class _____
4. Fish Species _____, _____, _____, _____, _____, _____, _____, _____

Data Source: _____

Data Source: _____

Data Source: _____

Data Source: _____

Data Source: _____

Data Source: _____

10. Coordination: _____

11. Comments: _____

Page: of

1. Reach # ___ RM ___ to ___
2. Valley Form _____
3. Valley Width Class 1_ 2_ 3_ 4_
4. Flow Regime Change _____
5. Sinuosity H___ M___ L___ S___
6. Average Reach Gradient _____
7. Stream Canopy Closure 1_ 2_ 3_ 4_
8. Other _____

9. General Comments: _____

R6-2500/2600-21

A. State _____ B. County _____ C. Forest _____ D. District _____
 E. Stream Name: _____
 F. Watershed Code _____, _____, _____, _____ NFS _____, _____; _____, _____, _____, _____
 G. USGS Quad: _____
 H. Survey Date: ____/____/____
 Year/ Month /Day
 I. Name: _____

1. Reach # ____ 2. NSO ____ to ____
 3. Flow _____
 4. Channel Entrenchment D ____ M ____ S ____
 5. River Mile ____ to ____
 6. Sinuosity value _____
 7. Average Channel Gradient _____
 8. Valley Length _____
 9. Valley Form _____
 10. Valley Width Class 1 ____ 2 ____ 3 ____ 4 ____
 11. Stream Canopy Closure 1 ____ 2 ____ 3 ____ 4 ____
 12. Dominant/Subdominant a.) ____ b.) ____
 Substrate _____
 13. Inner Riparian Zone Width _____
 14. Comments _____

 15. Observer: _____
 Recorder: _____
 16. Date: ____/____/____
 YY/MM/DD

1. Reach # ____ 2. NSO ____ to ____
 3. Flow _____
 4. Channel Entrenchment D ____ M ____ S ____
 5. River Mile ____ to ____
 6. Sinuosity value _____
 7. Average Channel Gradient _____
 8. Valley Length _____
 9. Valley Form _____
 10. Valley Width Class 1 ____ 2 ____ 3 ____ 4 ____
 11. Stream Canopy Closure 1 ____ 2 ____ 3 ____ 4 ____
 12. Dominant/Subdominant a.) ____ b.) ____
 Substrate _____
 13. Inner Riparian Zone Width _____
 14. Comments _____

 15. Observer: _____
 Recorder: _____
 16. Date: ____/____/____
 YY/MM/DD

1. Reach # ____ 2. NSO ____ to ____
 3. Flow _____
 4. Channel Entrenchment D ____ M ____ S ____
 5. River Mile ____ to ____
 6. Sinuosity value _____
 7. Average Channel Gradient _____
 8. Valley Length _____
 9. Valley Form _____
 10. Valley Width Class 1 ____ 2 ____ 3 ____ 4 ____
 11. Stream Canopy Closure 1 ____ 2 ____ 3 ____ 4 ____
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 Substrate _____
 13. Inner Riparian Zone Width _____
 14. Comments _____

 15. Observer: _____
 Recorder: _____
 16. Date: ____/____/____
 YY/MM/DD

Pg 78

1. Reach # _____ 2. Natural Sequence Order # _____ 3. Culvert # _____

4. Type of structure (check)
Round Pipe Box Arch Open Arch Open Box Elliptical

5. Length of Structure _____ (ft) 6. Diameter or width _____ (ft)

7. Gradient of Structure _____ % 8. Are Baffles Present? _____

9. Jumping distance into culvert from pool: Height _____

10. Pool present below structure (circle) Yes No

11. Pool Length _____, Width _____, Depth _____ 12. Stream Seg. Id. _____

13. Stream above culvert: Width _____, Gradient _____

14. Obs/Rec _____

1. Reach # _____ 2. Natural Sequence Order # _____

3. Falls Number: _____

4. Falls/ Chute/ Dam (circle one) # _____

5. Stream Survey Mile: _____ 6. Topo map elevation: _____

7. Size: Length _____ Width _____ Height _____

8 Gradient: _____ %

9. Is pool present below structure (circle one) Yes No

10. Pool Length _____ Width _____ Depth _____

11. Obs/Rec: _____

12. Comments: _____

1. Reach # _____ 2. Natural Sequence Order # _____

3. Falls Number: _____

4. Falls/ Chute/ Dam (circle one) # _____

5. Stream Survey Mile: _____ 6. Topo map elevation: _____

7. Size: Length _____ Width _____ Height _____

8 Gradient: _____ %

9. Is pool present below structure (circle one) Yes No

10. Pool Length _____ Width _____ Depth _____

11. Obs/Rec: _____

12. Comments: _____

1. Reach # _____ 2. Natural Sequence Order # _____
3. Falls Number: _____
4. Falls/ Chute/ Dam (circle one) # _____
5. Stream Survey Mile: _____ 6. Topo map elevation: _____
7. Size: Length _____ Width _____ Height _____
8 Gradient: _____ %
9. Is pool present below structure (circle one) Yes No
10. Pool Length _____ Width _____ Depth _____
11. Obs/Rec: _____
12. Comments: _____

H. Survey Date: ____/____/____
Year/ Month /Day

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Page: of

I. Reach Number

**Electroshock
(E)**

FOREST LEVEL DECISIONS

FORM B

Inner Riparian Zone Width: Forests shall determine consistent standards for determining inner and outer riparian zone width.

FORM C

Orientation Standards: Forests need to establish standards for "left bank" and "right bank" orientation. Note that the USGS standard establishes orientation while looking downstream.

Habitat Types: Forests shall determine consistent standards for pools, riffles, glides, and side channels.

Tributaries: Forests shall determine the significance for determining inclusion or exclusion in the survey.

Maximum Depth: Forests shall determine if depths will be measured, or estimated and measured (same as width and length variables). If all depths are measured, this value will need to be entered in the software as both estimated and measured values at each Nth unit. At all "non-Nth" units, enter the actual measured value as ONLY the estimated value. This will establish a correction factor of 1.0 for the depth.

Large Woody Debris: Forests shall determine consistent standards for including leaning trees (potential LWD) in counts of LWD. Standards should include angle of lean, distance from stream, etc.

Bankfull Width: Forests shall determine consistent standards for defining bankfull channel width.

Fish Species and Size Classes: Forests have the flexibility to add additional fish species codes and to collect additional size class information if needed. Work with Forest personnel to develop a consistent method to code the information.

REVISIONS TO VERSION 5.0

The following changes have been made in version 5.0. They address technical limitations in computer software as well as reflect mutual decisions between Forests and the Region following 3 years of operational testing of the methodology.

General:

1. **Measurements:** In order to comply with current GIS Standards, all measurements must be taken in English Standard. This will ensure compatibility of databases across the Region.
2. **Side Channels:** Based on forest consensus, side channel habitats will no longer be stratified. Treat each side channel as a single habitat unit, and collect *only* the following information: wetted length, width and depth.
3. **Reach Delineation:** Where private land is encountered and *access allowed*, *do not* separate the private land as a separate reach; include it as part of the reach defined by the geomorphic criteria. Where *access is denied*, artificially separate the private land and label it a separate reach. *DO NOT* identify or assign any habitat units to the reach.
4. **Watershed Codes:** The GIS standard for labeling streams is employed in the manual. See Appendix K for stream delineation procedures.
5. **Fish Species Identification:** The GIS Standard for identifying fish species is used: Use the first 2 alpha characters of the genus and species to generate a 4 digit alpha code. Follow AFS standard as identified in "A list of Common and Scientific Names of Fishes from the United States and Canada", 4th edition, 1990, Special Publication No. 12. Each Forest shall develop a species list with common names for cross reference.
6. **Calibration Ratios** are developed for each observer by watershed. It is important for observers and recorders to maintain their respective roles through an entire reach. Change roles only at the beginning of a new reach.
7. **NSO's and Habitat Unit Numbers:** Each habitat type has a unique NSO and Habitat Unit Number. If a long habitat unit is stratified, each subsection of that habitat unit shall follow this rule.

Forms:

1. **Header Information:** All forms have been revised to facilitate data entry in the Oracle Software. Note on Form B2, the observer and recorder information is required for each reach. This will ensure that appropriate correction factors are generated for each reach.
2. **Form D:** Enter actual number of fish observed in one of 2 categories: adults and juveniles.

REVISIONS TO VERSION 6.0

1. The Stream Inventory Handbook was revised to clarify several items and make it easier to locate information.
2. The standard for the minimum number of measured habitat units needed to develop statistically valid correction factors was clarified. A minimum of 10 pools, 10 riffles, and 10 glides will be measured for each observer on each stream.

On longer streams, where the required number of measured units will be met, the minimum sampling frequency for pool, riffle, and glide units will be 10 percent.

3. NFS Watershed Code Stream Mileage Identifiers should begin at the mouth of the mainstem which forms the NFS **Subwatershed** and proceed upstream until the specific surveyed tributary is reached. See Appendix A.
4. For Form B2, average reach gradient should be calculated from topo maps using the final reach boundaries.
5. The procedure for taking Bankfull Width and Bankfull Depth measurements has been modified. These measurements should now be recorded at each measured **riffle** rather than at each measured pool as specified in previous versions.
6. Bank Stability has been added to the data collected on Form C (#28). This data should be collected at each measured unit.
7. Water temperature should be taken a minimum of 3 times per day in the main channel. Temperatures must be taken and recorded on measured main channel units or on tributary units only. Any temperatures recorded on non-measured mainchannel units will not show up in the SMART summary tables.

STREAM SURVEY

Level II

ROGUE RIVER NATIONAL FOREST

Ashland Ranger District

Little Applegate River

1992

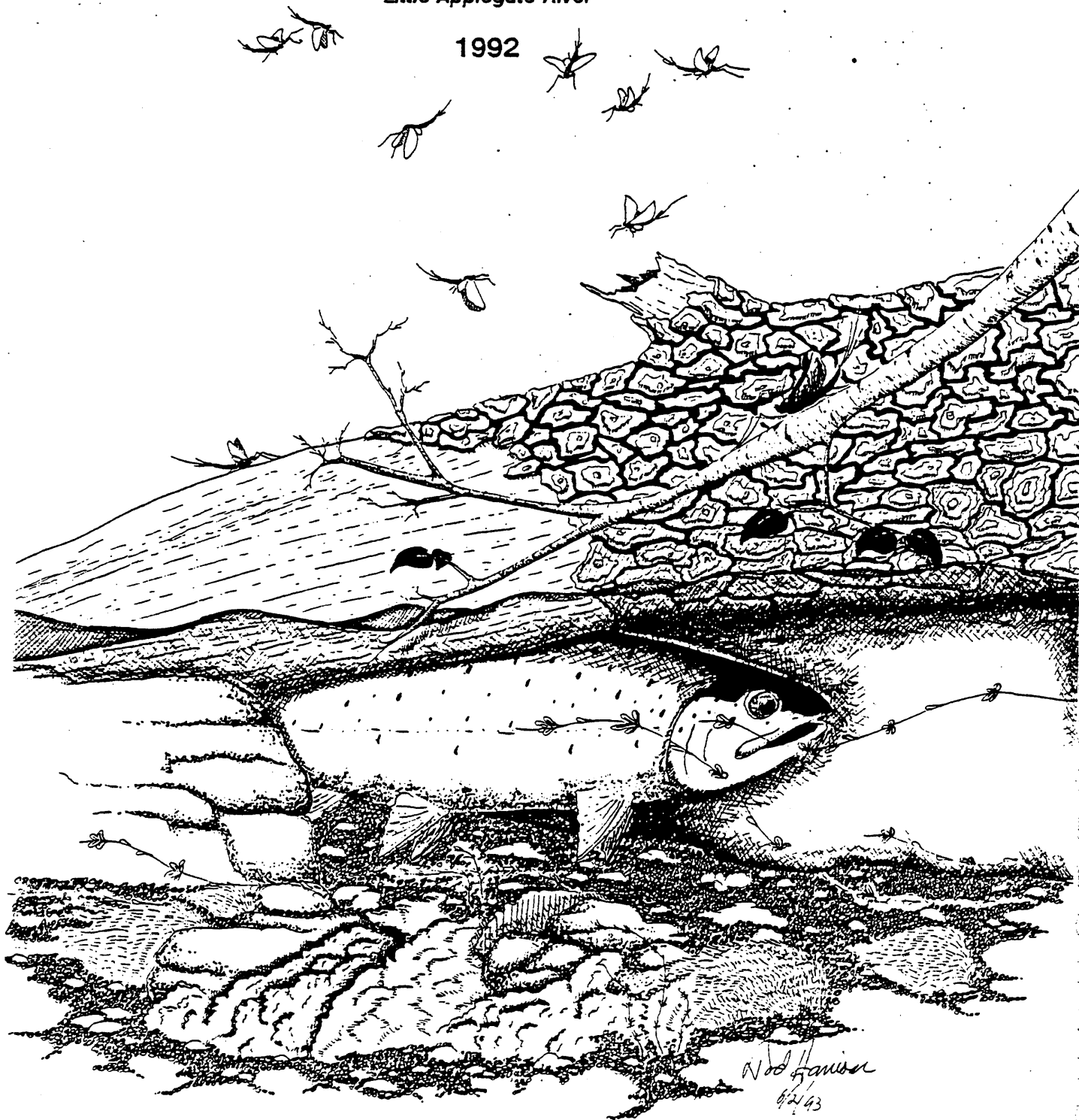


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Written by: *Susan J. Maiyo, Fisheries Biologist, Ashland District*

Reviewed by: *Randall G. Frick, Forest Fisheries Biologist*

EXECUTIVE SUMMARY

R-6 Stream Survey Level II

Little Applegate River Rogue River National Forest Ashland/Applegate Ranger District

INTRODUCTION:

The purpose of the executive summary is to highlight key attributes and issues for the Little Applegate River basin. The lower three stream reaches were surveyed and analyzed during 1991-1992. Below is a discussion of the stream attributes graphed on the accompanying page, an explanation of the issues, and a management recommendation for the basin.

DESCRIPTION:

- Little Applegate River is an important anadromous fishery in the Rogue River Basin.
- Summer and winter steelhead and occasionally coho salmon spawn and rear on National Forest Lands within the Little Applegate Basin.
- Approximately 10 miles of stream accessible to anadromous fish are within the boundary of the Rogue River National Forest.
- Watershed totals 80,000 acres; approximately 25,000 acres are within the Forest boundary.
- Significant populations of resident trout are present in the upper portions of Little Applegate River and its tributaries.
- Most of the basin is comprised of decomposed granitic soils which are highly erosive.

ISSUES:

- Human intervention in the basin started during the 19th century when miners exploited the stream for placer gold.
- Activities which have impacted aquatic and riparian habitat include:
 - Dredging and placer mining within the stream channel.
 - Stream cleanout and utilization of the stream channel and riparian zone for transportation.
 - Resulted in a deficit of large woody material in the channel and riparian vegetation in hardwood early seral stage.
 - Burning of vegetation in the basin and damming of the stream for water diversion which impeded the passage of migrating fish.
- Private lands in the middle elevations of the basin were harvested prior to the 1964 flood. The poor logging practices used exacerbated the effects of 1964 and 1974 flood events.
- Gully erosion on private and public lands from roading and logging has added considerable sediment to the stream channel.
- Health of the lower three stream reaches is dependent on cooperation with Medford Corporation, owners of most of the stream above McDonald Creek.
 - Water temperatures increase in this section due to poor shade conditions and lack of large wood to deepen the channel.
 - Sediment from Medco lands and McDonald basin is detrimental to the stream.

EXPLANATION OF GRAPHS:

The **GOOD** range shown on each of the graphs represent the desired future condition of each stream attribute. Specifics about the DFC's are elaborated upon in the body of the stream survey report.

Graph 1, Temperature:

- Stream temperatures were measured during the 1991-92 summers with temperature clock instruments and pocket thermometers. The temperature graph shows these results. Salmonids thrive in streams with water temperatures between 55 F and 65 F.

- Temperatures are rated overall as **FAIR**. This means that water temperatures were higher than optimum for salmonids.

Graph 2, Large Wood Materials:

- Large wood is important for stream structure and habitat complexity, sediment storage, bank protection and for delivery and storage of photosynthesized products to the aquatic environment.
- Little Applegate River is rated as **POOR** because of a deficiency of large wood in the stream channel.

Graph 3, Pool:Riffle:Glide Ratio:

- Healthy streams of similar geomorphology approach a 40:60 ratio of pools and riffles with the presence of flow dissipating elements in the stream channel. These features include large wood, small and large boulders, bedrock areas, and side channel areas.
- Little Applegate River is rated **POOR** because of a high riffle component in all stream reaches.

Graph 4, Width:Depth Ratio:

- Width to depth ratio is a measure of the channel cross-section. Ratios that exceed 10 indicate a stream channel that is wide and shallow, generally contains few features and is aggrading from sediment input.
- Stream Reaches 1 and 3 are near a width:depth ratio of 10, while Reach 2 is favorable at a ratio of 3.99.
- Overall the width:depth rating is **FAIR**.

Graph 5, Watershed Rating:

- Little Applegate rates **POOR** or high risk because of high road density in the basin - 2.88 miles/square mile and 17% of the basin in stands less than 30 years old. The basin's geology - highly erosive decomposed granitics - requires careful consideration of where activities take place. Headwall areas or sensitive stream channels can cause exponential impacts to the stream if not managed properly.

MANAGEMENT RECOMMENDATIONS:

Priority One:

- **Reinstate the conifer component** in the riparian zone in all three reaches.
- Plant and culture conifers to achieve a DFC of 85% conifer and 15% hardwoods in late seral stage. This will insure future large wood contribution to the stream channel and floodplain.

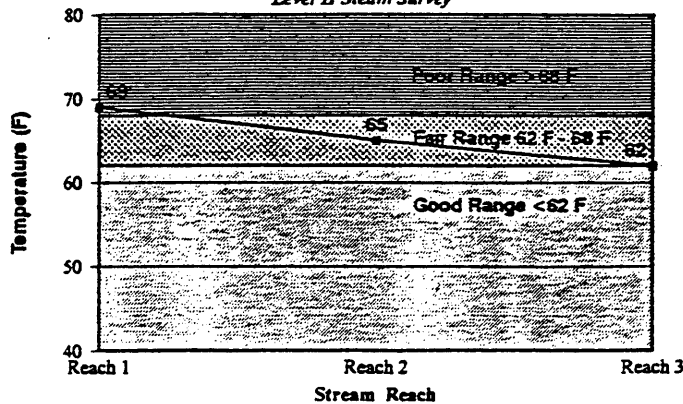
Priority Two:

- **Conduct watershed inventory (WIN)** to identify temporary roads, road drainage systems and high-erosion areas which are contributing sediment to the stream channel.
- Prioritize projects to begin restoring these areas and request watershed, fisheries and engineering money to repair and revegetate.

Priority Three:

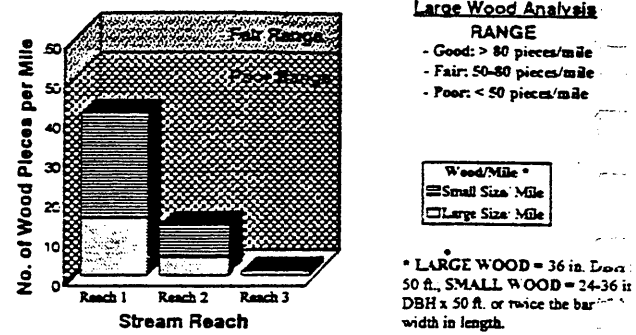
- **Diversify habitat:**
 - Place large wood material in Reach 2 to create more habitat complexity.
 - Utilize large wood pieces longer than twice the bankful width and a mix of small and large boulders to create this complexity. Use these materials to stabilize streambanks by placing them at high profiles on the banks.
 - Restore historic side channel habitat in low gradient areas.

Graph 1
Temperature Data
Little Applegate River
Level II Stream Survey



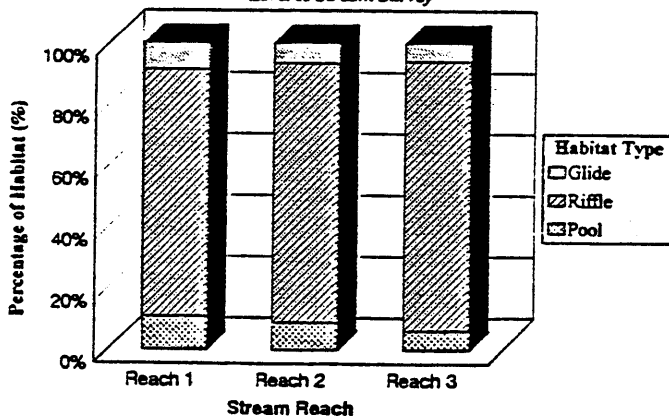
Maximum Temperature by Reach

Graph 2
Large Wood Material Analysis
Little Applegate River
Level II Stream Survey



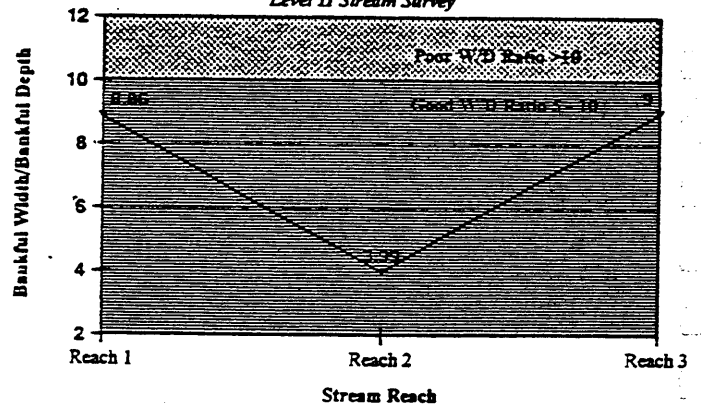
Desired Future Condition for Little Applegate River is 80 pieces of large and small wood per mile. Note that all reaches are below wood levels needed for channel health, good insect production and optimum salmonid fish production.

Graph 3
Pool/Riffle/Glide Ratio
Little Applegate River
Level II Stream Survey



Desired Future Condition is 40:60 Pool Riffle Ratio. Little Applegate is below pool habitat levels desired.

Graph 4
Width/Depth Ratio
Little Applegate River
Level II Stream Survey



Bankful width/bankful depth ratio > 10 indicates the stream channel is in poor condition, starting to fill with sediment and/or bank starts to degrade and peel away; stream became shallow and wider. Desired Future Condition is < 10 bankful width/bankful depth.

Graph 5
Watershed Risk Rating
Road Density versus Vegetative Cover
Little Applegate River

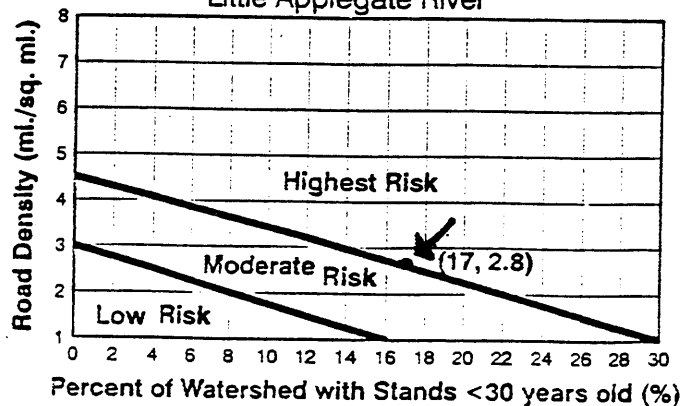


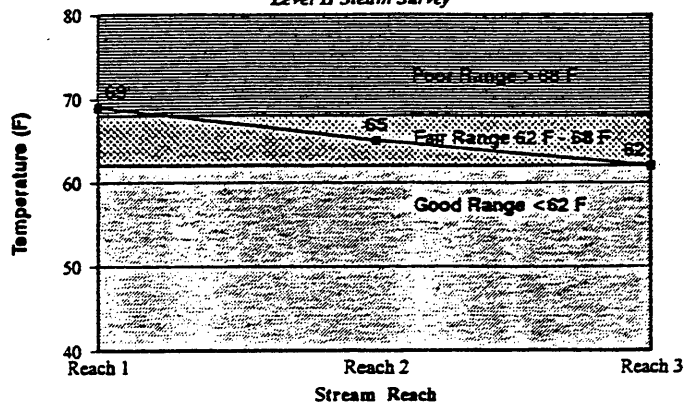


PHOTO 1: Riffle habitat in lower half of Reach 1. Riparian vegetation on the west side of this Reach is only 50 feet wide as a result of an adjoining harvest unit.



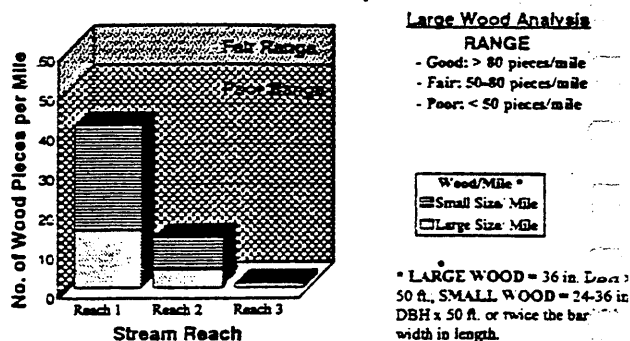
PHOTO 2: Reach 1 has an average of 41.5 pieces of large and small sized wood per mile and many quality pools. No roads in the riparian zone along Reach 1. This reach has been least effected by human activities of the three reaches surveyed.

Graph 1
Temperature Data
Little Applegate River
Level II Stream Survey



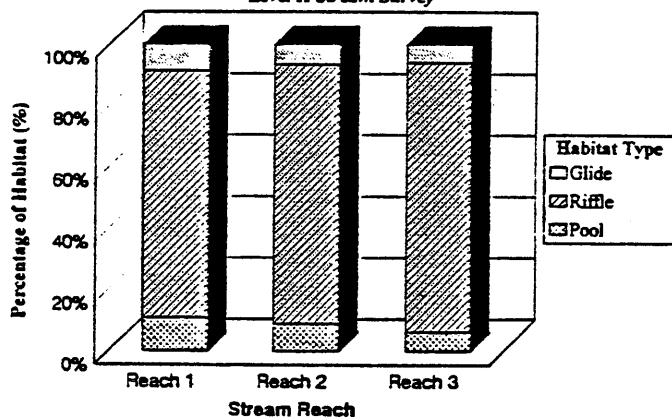
Maximum Temperature by Reach

Graph 2
Large Wood Material Analysis
Little Applegate River
Level II Stream Survey



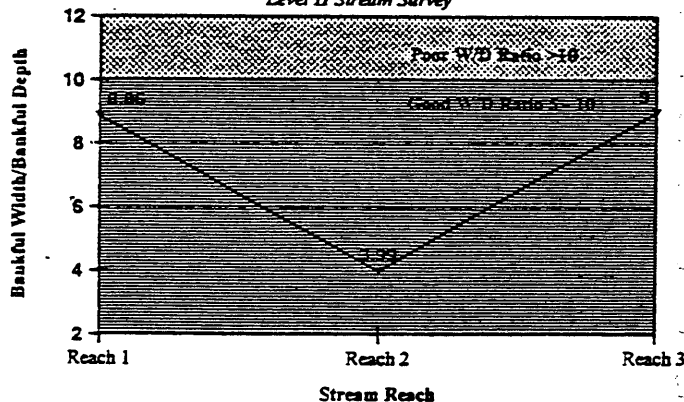
Desired Future Condition for Little Applegate River is 80 pieces of large and small wood per mile. Note that all reaches are below wood levels needed for channel health, good insect production and optimum salmonid fish production.

Graph 3
Pool/Riffle/Glide Ratio
Little Applegate River
Level II Stream Survey



Desired Future Condition is 40/60 Pool Riffle Ratio. Little Applegate is below pool habitat levels desired.

Graph 4
Width/Depth Ratio
Little Applegate River
Level II Stream Survey



Bankful width/bankful depth ratio > 10 indicates the stream channel is in poor condition, starting to fill with sediment and/or bank starts to degrade and peel away; it becomes shallow and wider. Desired Future Condition is < 10 bankful width/bankful depth.

Graph 5
Watershed Risk Rating
Road Density versus Vegetative Cover
Little Applegate River

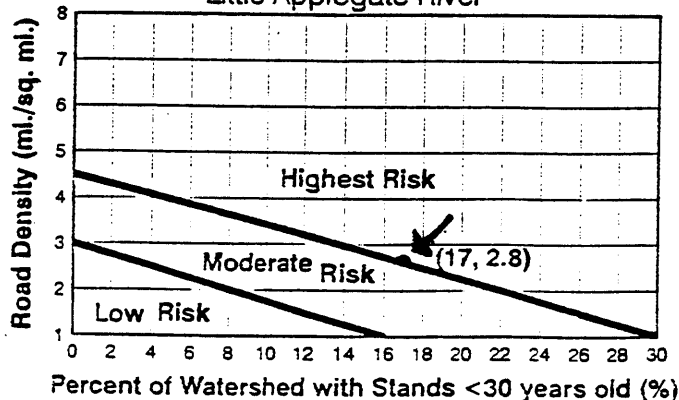




PHOTO 5: Riparian zone is generally open in Reach 3 and has been heavily impacted by past flood events and forest management.



PHOTO 6: Most of Reach 3 is accessible by road. FSR 2250200 is within 25 feet of the stream during the last 1,000 feet of the reach.



PHOTO 3: Sterling irrigation ditch is located on the north side of the stream in Reach 2. There is no screen present to prevent fish passage, and several nonmaintained sections exist causing erosion.

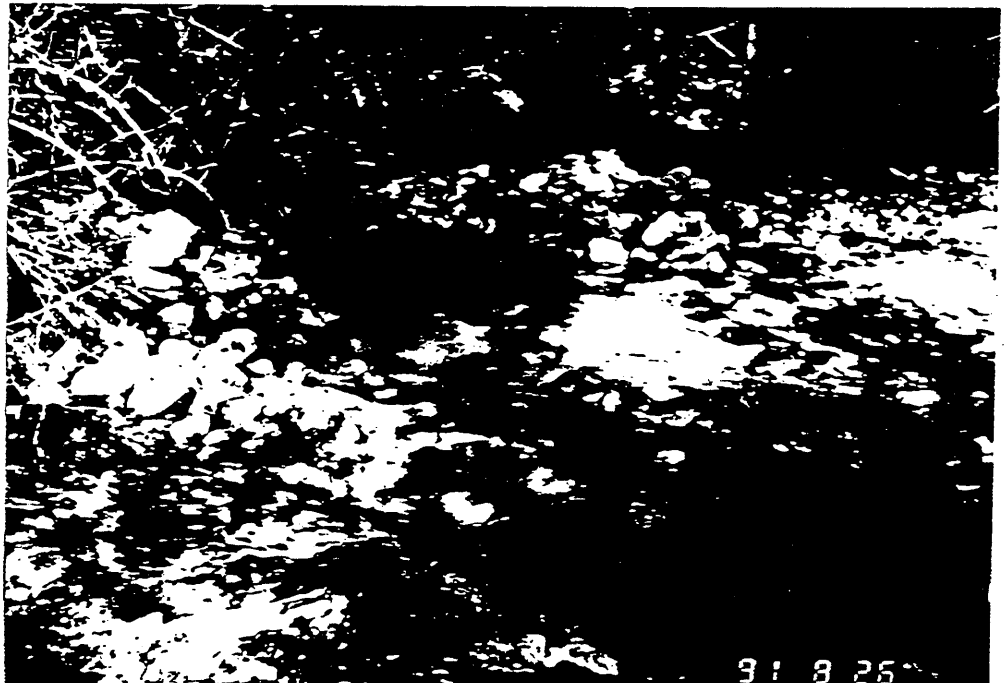


PHOTO 4: The results of past and present mining activity in Reach 2. Mining activities increase turbidity and sediment delivery.

Geology

- Located in the Siskiyou Mountains within the Klamath Mountain Geologic Province.
- 3 major rock types: diorites, serpentinites and metamorphic rocks consisting primarily of metavolcanic; in a decomposed granitic state.
- Productive for anadromous and resident fisheries, as much of the area was former ocean floor sediment and is rich in soluble minerals. High specific conductance (110 micromhos).
- An evaluation of slope stability was conducted by the Forest Geologist - areas with a high risk for landslide activity and gutted channels were located during field investigations. These areas are concentrated in or near side drainages and steep slopes.
- Average substrate: Reach 1 & 3 - sand and bedrock intermixed with small and large boulders; Reach 2 - cobble and gravel.
- Average stream gradient: Reach 1 - 4%; Reach 2 - 1%; Reach 3 - 3%.

Recreation

- Big game hunting, fishing and dispersed camping are important recreation uses adjacent to the Little Applegate River.
- Mining activities in Reach 2; creates turbidity and sediment.
- Five dispersed campsites are located along the Little Applegate River.

Range

- Little Applegate River is located within the Wagner Butte Cattle allotment. Twenty head of cattle are permitted on this allotment July through October.
- Cattle and sheep grazing before the turn of the century, occurred in the upper basin.
- Under normal growing conditions, most of the forage found has matured and is unpalatable to livestock by their July turnout date. As a result cattle turned out for grazing do not remain in the area; they tend to head towards the Siskiyou Crest Area and its associated meadows.

Vegetation

- Riparian habitat is interspersed among stands of old-growth, mature habitat, second growth, and hardwoods.
- Much of the floodplain is in alder and other hardwoods which do not attain the dimensions needed in streams this size.
- Minor amounts of Pacific Yew have been observed in protected riparian areas along the Little Applegate River.

Historic Uses

- Prospecting/mining, livestock grazing, hunting and fishing have occurred since the late 1800's.
- Two class A fires occurred in the late 60's and early 70's.

Roads

- Forest Service roads number 2250 and 2250200 are located with the riparian zone of the stream for many miles and in several sections the stream has been moved to accommodate the road facilities.

Reach Boundaries

- Reach 1: Applegate Ranger District/BLM boundary (0.6 miles downstream of Glade Creek) to Glade Creek.
- Reach 2: Glade Creek to Greely Creek.
- Reach 3: Greely Creek to McDonald Creek.

LITTLE APPLGATE RIVER

**Rogue River National Forest
Ashland/Applegate Ranger District**

BASIN OVERVIEW

The stream survey was conducted from the Applegate Ranger District/BLM boundary (0.6 miles downstream of Glade Creek) to the confluence of McDonald Creek and Little Applegate River, Ashland Ranger District. The portion of the river surveyed passed through six miles of stream on Forest Service and private landholding. Little Applegate River was surveyed to assess the riparian and aquatic habitat.

Watershed

- Little Applegate watershed basin from the FS/BLM boundary to the headwaters contains 26,980 acres.
- Little Applegate is classified as a Class I, third Order stream. McDonald Creek (Class I), Glade Creek (Class I), and Greely Creek (Class II) are three of the major tributary streams in the Little Applegate watershed.
- Water Gulch, Second Water Gulch and Skunk Gulch are minor tributaries in the watershed and classified as Class III streams.
- Area surveyed ranges from a streambed elevation of 2,880 feet to 3,680 feet.
- Erosion from decomposed granite exists on the roads found in the area. Some erosion is occurring within section 4 on skid trails. Past logging practices within this area located skid trails up steep slopes and drainages thus accelerating gullies and erosion. Erosion occurs each winter.
- Some sediment continues to be delivered to the channel. Relogging of private lands may increase sediment delivery.

Fisheries

- Important anadromous fish stream.
- Provides spawning and rearing habitat of steelhead trout, coho salmon, as well as resident cutthroat and rainbow trout populations.
- Steelhead/rainbow trout dominate this stream. Cutthroat trout were first observed near the confluence of McDonald Creek. Coho salmon were not observed.
- Fish surveys were conducted to determine species and age of fish only. All age classes were well represented.
- Highest population densities occurred in pool habitats with complex cover.
 - Wood and substrate components offered the best quality cover for salmonids.
 - Pools are lacking in Reach 2 and 3.
- Good population of aquatic insects with stonefly, mayfly, and caddisfly well-represented (these three insect families are indicators of good primary production).
- No fish barriers were noted.
- Stream temperature maximum was 69 degrees F. and minimum 49 degrees F. (recorded from a Tempmentor, 1992).

Flow regime

- The Talent Irrigation District diverts the water at McDonald Creek from June to August.
 - During nonirrigation season, McDonald Creek discharges 40% of the flow into Little Applegate River and 20% of flow during irrigation season.
- Glade Creek discharges 40% of flow and Greely Creek 10%.
- During 1992, a record drought year, flow was recorded at the Little Applegate Bridge on FSR 2250 as 3.06 CFS, 1991 flow recorded as 6.0 CFS. Glade Creek was recorded as 1.63 CFS, 1992.
- Sterling Ditch (upper Reach 1) removes 1 CFS during the irrigation season. This ditch is in need of maintenance.
- Variable flow regime; most of the basin is in the transitory snow zone; rapid snow melt can occur during winter storms.
- Basin has been impacted by timber harvest. Seventeen percent (17%) of the basin within the National Forest has vegetation less than 30 years old.

MANAGEMENT RECOMMENDATIONS

Priority One

- **Riparian silviculture to reinstate mature conifers** through riparian planting; allows for natural vegetation succession and eventual return of the floodplain to mature conifers in Reaches 2, Section 4 and Reach 3. This will provide future supply of large wood to channel and floodplain.
- Placement of large wood and boulders on the active 10 year floodplain will protect young seedlings during high water events and provide microhabitat.

Priority Two

- **Conduct watershed inventory (WIN)** to identify temporary roads, road drainage systems and high erosion areas which are contributing sediment to the stream channel.
- Prioritize areas to begin restoring these areas and request watershed, fisheries and engineering money to repair and revegetate these sites.

Priority Three

- **Diversify habitat:**
 - Dissipate stream energy at all flow levels.
 - Create pool habitat with complex overhead cover for juvenile salmonids in Reaches 2 and 3.
 - Protect streambanks and sort substrate materials for better spawning habitat in Reaches 2 and 3.
 - Placement of whole trees or large wood pieces with roots attached and boulders within the main channel for rearing habitat and raise the potential for rearing larger trout. Concentrate work in areas with no immediate or potential recruitment of woody material from the floodplain in Reaches 2 and 3.
 - Protect present woody material in the system from removal in all Reaches.
 - Large hydrologic channel features such as large wood complexes and scour elements to form quality pools and rearing area with complex cover elements; trap and store fine mineral materials.

Priority Four

- **Stabilize stream banks, floodplain and basin slopes** in Reaches 2 and 3:
 - Modify land use practices; lessen streambank soil disturbance and bank vegetation removal.
 - Placement of woody material to protect streambanks which lack bank armoring.
 - Woody and boulder material should be placed to dissipate energy and create a meandering pattern. (This will create side channel habitat preferred by coho salmon.)
 - Survey and document basin slopes in high risk areas using the WIN inventory protocol.
 - Stabilize landslide and gutted channel activity

Priority Five

- **Cooperatively work with mining claim recipients** in their land use activities.
- **Cooperatively work with Sterling Ditch recipient** in proper usage and maintenance of intake and removal of water.
 - Continue to monitor usage of Sterling Ditch (see Sterling Ditch Usage report 1991, Ashland Ranger District).
 - Cooperate with ODFW to prevent fish passage.
- **Survey Class III and IV streams** in the basin and prescribe watershed restoration projects to stabilize aquatic and riparian habitat.

DESIRED FUTURE CONDITION

- Stream temperature between 55 and 65 degrees F.
- Eighty (80) pieces of large and small woody size class (per Level II) material per mile.
- Pool/riffle ratio approaching 40:60 ratio.
- Width to depth ratio less than 10.
- 25 pools per mile.
- Fisheries include a viable population of coho salmon, steelhead, rainbow, and cutthroat trout.
- Watershed vegetation composed of conifer stands 35 years or older in 75% of basin area (see Graph 5).
- Riparian vegetation 0 to 100 feet from the edge of the stream would be a mix of 75% conifer and 25% hardwood component in a mature age class.
- Areas of low gradient would have side channels present.
- Channels with gradients of less than 2% would be less entrenched.
- Substrate would be gravel/cobble mixture intermixed with small boulders.
- Road density of less than 2 miles per square mile.

MANAGEMENT ISSUES

- Stream temperature ranges from poor (Reach 1) to good (Reach 3)(see Graph 1).
- Woody material is lacking in the stream channel and rated in the poor range (see Graph 2).
- Pool:riffle ratio is approximately 8:80 (see Graph 3). This does not reflect pocket pool habitat present in small boulder substrate areas.
- Width to depth ratio in Reach 1 and 3 are in the fair range (see Graph 4).
- Road density is greater than 2 miles per square mile and rated in the poor range (see Graph 5).
- Pools per mile is good in Reach 1 (23); low (16 and 11) in reach 2 and 3 respectively.
- Effective cover is below optimal conditions; this may be accounted for, by land use practices such as timber harvesting and mining which exacerbate the effects of the 1964 and 1974 floods.
- Banks are in good condition except in areas where streambank vegetation is sparse and lacks woody material.
- Riparian zones in Reach 2 and 3 are primarily sparse vegetation consisting of willow and alder.
- FSR 2250200 was developed in or near the riparian zone of the stream in Reach 2 and 3 during 1964 and 1974. This started a cycle of salvage and stream cleanout which negatively impacted the fish habitat.
- Contains adequate numbers of salmonids, but few large enough to support a recreational fishery. The aquatic production to accommodate a wide variety of age classes of cutthroat and rainbow trout is in place.
- Sideslopes of the stream valleys adjacent to the main channel and the tributaries are steep.
- Sterling Ditch, Reach 2, was evaluated in 1991. There is no screen present to prevent fish passage and several nonmaintained sections exist causing erosion.
- Erosion is occurring within Section 4 on skid trails. Past logging practices within this area located skid trails up steep slopes and drainages; accelerating gullies and erosion. These areas continue to erode each winter.
- History of flash floods and debris torrents causing landslides; frequency increased by timber harvest and road-building activities.
- Mining activities in Reach 2 increases turbidity and sediment delivery.
- Human impacts to the Little Applegate watershed include: wood removal, road creation, irrigation, mining, and recreation.

Reach 3: Substrate consists of sand and bedrock respectively, fair amounts of small and large boulder features are present.

LARGE WOODY MATERIAL

Wood Classes: Large size wood - 36" x 50', Small size wood - 24" x 50', Brush size wood - 12" x 25'. If the wood does not meet the length class but is twice the bankfull width, then record according to width class.

Most wood in the area surveyed are located in large wood complexes lodged at hydrologic nick points. The large and small pieces are the foundation of these complexes with brush-sized woody material collected at these points.

- Reach 1: 14.5 pieces of large and 26 pieces of small sized wood per mile are present. 34 pieces of brush sized wood per mile is present.
- Reach 2: 5 pieces of large and 8 pieces of small sized wood per mile are present. 25 pieces of brush sized wood per mile is present.
- Reach 3: No large wood is present. 1 piece of small and 11 pieces of brush sized wood per mile are present.

REFUGE COVER FOR SALMONIDS

Refuge Cover Classes (Percent of habitat unit area): Poor 0-25%, Fair 26-50%, Good 51-75%, Excellent 76-100%

Cover was rated for salmonids over 1 year of age (1+).

- Reach 1: Cover is fair to good in Reach 1 due to considerable turbulence in pocket pool habitat and interspaces of boulders and cobbles.
- Reach 2: Cover is poor to fair in Reach 2 due to considerable low wood and low interspaces between cobble and gravel.
- Reach 3: Cover is poor to fair in Reach 3 due to considerable low wood and low interspaces between cobble and gravel.

FISH SPECIES

Fish were observed by electrofishing and snorkeling techniques. All age classes were found. 1+ age class dominated.

- Reach 1: *Steelhead/rainbow trout were the only fish species found.
- Reach 2: *Steelhead/rainbow trout were the only fish species found
- Reach 3: *Steelhead/rainbow trout were found throughout the whole reach, cutthroat were observed near the confluence of McDonald Creek.

* Coho have been observed in past years throughout area surveyed.

STREAMBANK GROUND COVER AND SUBSTRATE

Ground Cover Classes (Percent of streambank armoured): Poor 0-25%, Fair 26-50%, Good 51-75%, Excellent 76-100%

Streambanks are composed of highly erosive granitic soils throughout area surveyed.

- Reach 1: Bedrock/cobble/small boulder streambanks were rated good (51-75%) armouring against scour from bankfull flow.
- Reach 2: Bedrock/sand streambanks were rated excellent (76-100%) armouring against scour from bankfull flow.
- Reach 3: Cobble/sand streambanks were rated fair (26-50%) armouring against scour from bankfull flow.

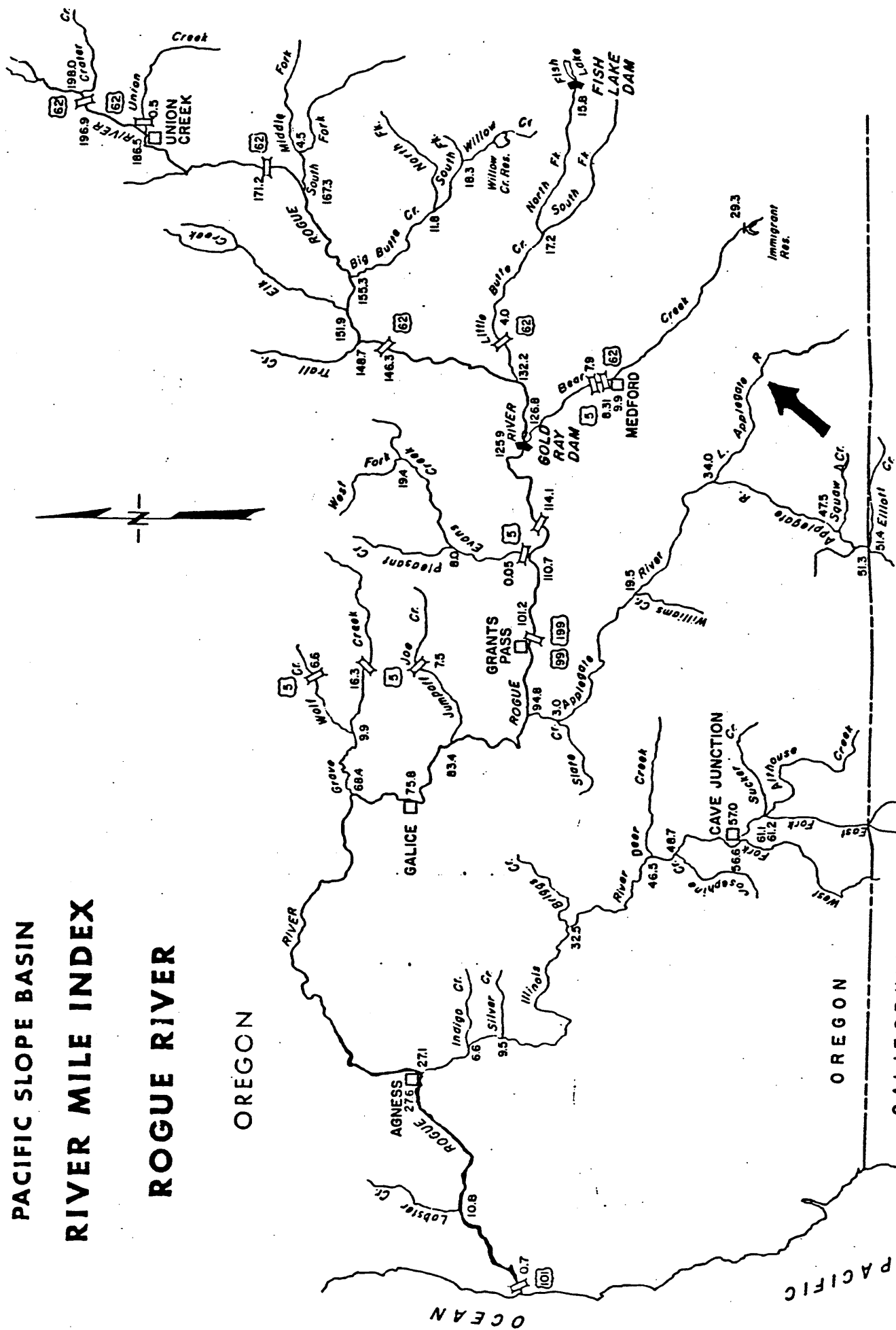
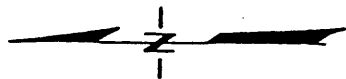
PACIFIC SLOPE BASIN RIVER MILE INDEX

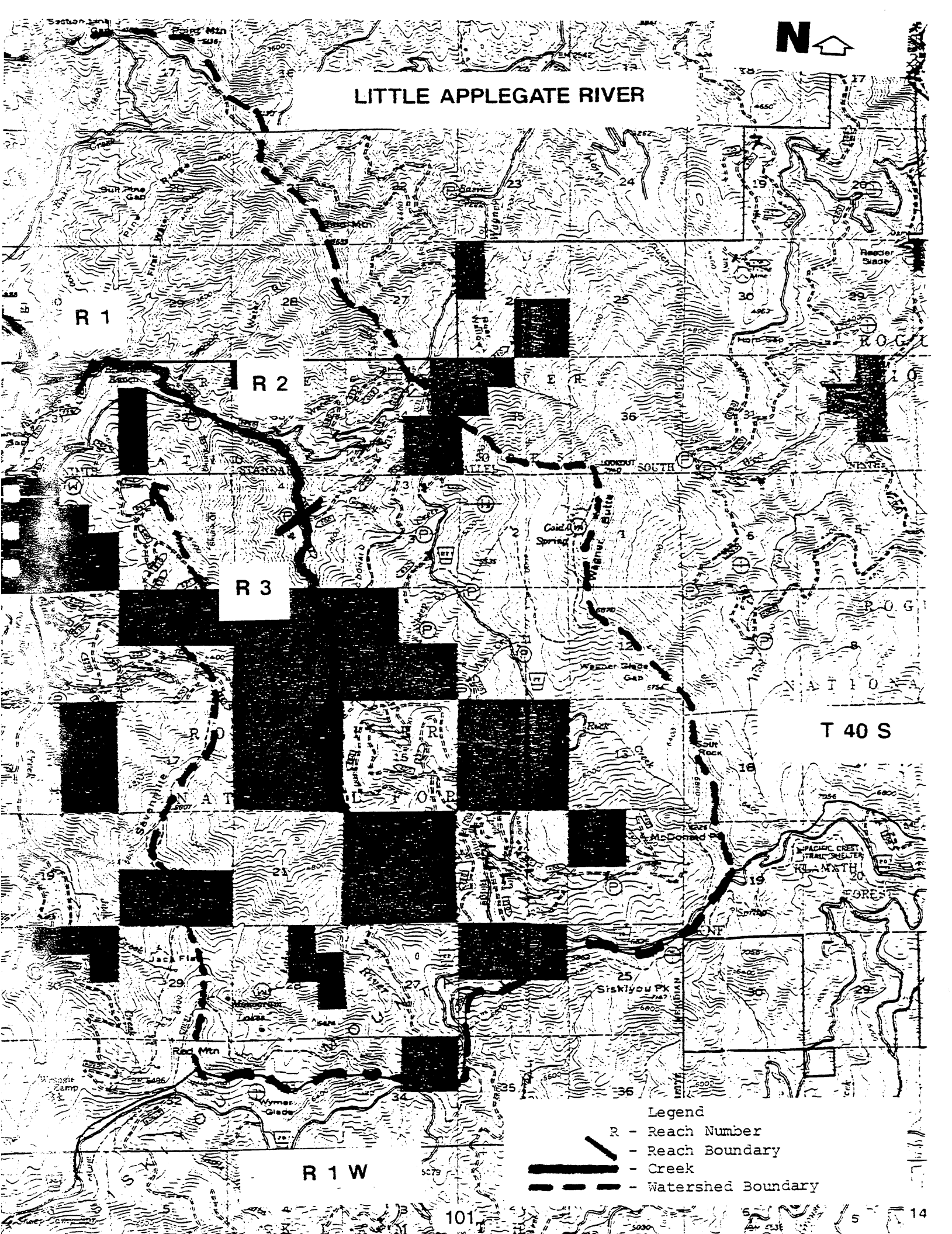
ROGUE RIVER

OREGON

OREGON

CALIFORNIA





LITTLE APPLGATE RIVER

R 1

R 2

R 3

T 40 S

R 1 W

Legend

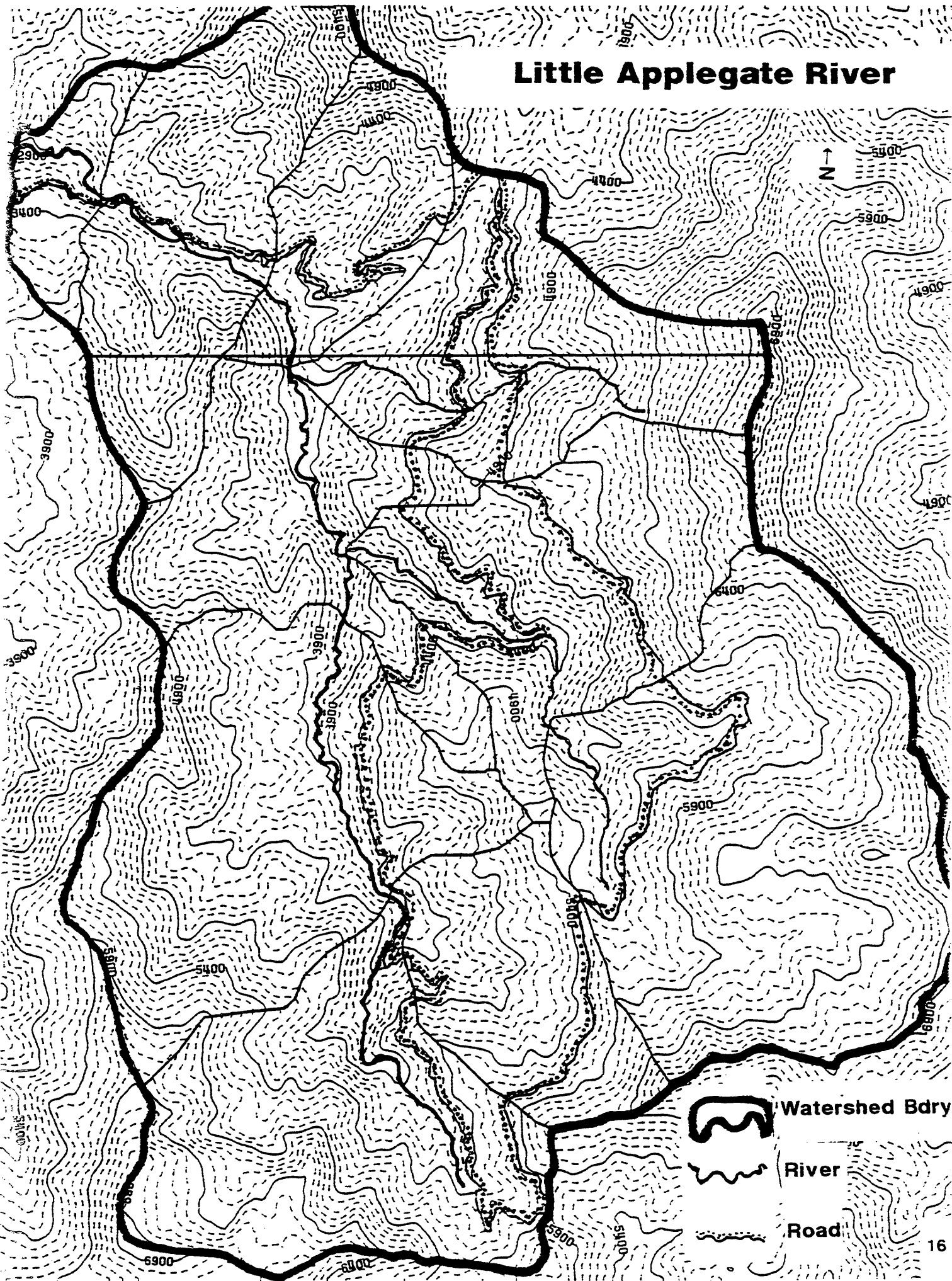
R - Reach Number

- Reach Boundary

- Creek

- Watershed Boundary

Little Applegate River



Stream Survey Management
Basin Summary

**Stream Name : LITTLE APPLGATE
Year : '91

Reach Number	Mile From	Mile To	NSO From	NSO To	Sinu- osity	Corrected Length in ft	%Area	%Volume	Bankfull WD Ratio	Pools/ Mile	% Pools
1	0	.6	1	39	3	4002.3	16.8%	24.4%	8.86	23.3	17.7%
2	.6	3.4	40	229	4	12727.5	52.9%	45.0%	3.99	16.8	15.1%
3	3.4	4.7	30	309	3	7594.0	30.3%	30.6%	9.00	11.5	10.9%
										17.2	14.5%
										24323.8	

Stream Survey Management
Reach Characterization

Stream Name : LITTLE APPLGATE
HUC : 17.10.3.9.2.A.1.5..1
Year : '91

Reach No	River Mile From	River Mile To	Vlly Form	Sinuosity	Ent	Substrate*		Grade	Valley Length	Width Class
1	0.0	0.6	8	3	M	SA	BR	4%	2.75	2
2	0.6	3.4	9	4	S	CO	GR	1%	0.63	4
3	3.4	4.7	8	3	M	SA	BR	3%	0.38	2

Stream Survey Management
Hydrology Summary

Stream Name : LITTLE APPLGATE
Year : '91

Reach	Miles	Snsty	Avg Ch Vy Cn Flow				Correctd	Correctd	Corrected Avg			Substrate*				* Mx*			
			Grd	En	WC	Cv	in CFS	Length in ft	Area in SqPt	Volume in CuPt	Width in ft	Bankfl1 W/D Rto	Resid Depth	Bed D	Bank S	Bank D	Gd Cv	Em bd	of Tim
1	.6	3	4	M	2	2	6	4002.3	60384.9	137249.2	17.9	8.86	2.3	SA	GR	BR	SA	3	Y
															CO				
															SB				
2	2.8	4	1	S	4	1	0	12727.5	189534.5	253422.5	16.4	3.99	1.8	CO	SA	BR	SA	4	Y 65 1900
															SA				
3	1.3	3	3	M	2	1	0	7594.0	108464.6	172520.8	15.7	9.00	2.1	CO	SA	CO	CO	2	Y 55 120
																SA			55 1330
							24323.8	358384.0	563192.5										

USDA Forest Service
Region 6

Stream Survey Management
Fisheries Habitat Summary

**Stream Name : LITTLE APPLEGATE
Year : '91

			Length	LWD	Large	Small	Brush	Area in								
Reach	Mile From	To	in feet	/Mile	/Mile	/Mile	/Mile	Sq Feet	% P	% R	% G	% S	% F	Cover*	Dom*	Sbd*
1	0	.6	4002.3	75.2	14.5	26.4	34.3	60384.9	10.9%	80.3%	8.6%	0.2%	0.1%	2	T	S
2	.6	3.4	12727.5	37.8	4.6	7.9	25.3	189534.5	8.9%	83.3%	6.5%	1.1%	0.3%	1	T	S
3	3.4	4.7	7594.0	12.5	.0	1.4	11.1	108464.6	6.2%	85.8%	5.8%	2.2%	0.0%	1	T	S
			24323.8													

USDA Forest Service
Region 6

Stream Survey Management
Riparian Vegetation Summary, Zone 1

Stream Name : LITTLE APLEGATE
Year : '91

Reach	Mile From - To	Zone Width	Floodplain Vegetation, Zone 1						GF*		SS*		SP*		ST*		LT*		MT	
			GF	SS	SP	ST	LT	MT	D	S	D	S	D	S	D	S	D	S	D	S
1	0 .6	25			100%								HA	CC						
													CT							
													HB							
													HE							
													HW							
2	.6 3.4	25	6%	24%	71%				GF	HA	HA	HW	HA	HV						
3	3.4 4.7	25		80%	20%						HW	HA	HA	HW						

Stream Survey Management
Riparian Vegetation Summary, Zone 2

Stream Name : LITTLE APLEGATE
Year : '91

Reach	Mile From - To	Zone Width	Floodplain Vegetation, Zone 2						GF*		SS*		SP*		ST*		LT*		MT*	
			GF	SS	SP	ST	LT	MT	D	S	D	S	D	S	D	S	D	S	D	S
1	0 .6	75				83%	17%								CD	HM	CD	CC		
2	.6 3.4	75	6%	6%	12%	76%			GF	CD	CC	CD	CD	CC	CD	CC				
													HM		CD					
3	3.4 4.7	75		20%	40%	40%					CW	CA	CD	CY	CD	CC				
													HW		HA					

PAST STREAM SURVEY

SURVEY DATE: 04/23/70 AND 07/02/70

SURVEYED BY: Jay O. Hoover and Bill Harbaugh

UNIT SURVEYED: Glade Creek upstream to about the middle of Sec. 27, (T.40S., R.1W) a distance of about 7 stream miles.

WATER TEMPERATURE: 54 F. on 07/02/70 AT Skunk Gulch.

STREAM FLOW: EST. 18 CFS 07/02/70

STREAM COVER: Approximately 70% shade.

WATER COLOR: Clear

AVERAGE WIDTH: 18 feet.

POOL/RIFFLE RELATIONSHIP: 20% pools

GRADIENT: 5%

DEBRIS: Very Little

AQUATIC WEEDS: None

TRIBUTARIES: McDonald Creek est. 3 CFS

BARRIERS: None

BOTTOM COMPOSITION: Only about 20% of the bottom is composed of material less than 3 inches in diameter.

HABITAT: Fair to good.

FISH: Rainbows moderate population

RECOMMENDATIONS: None

I. Reach Number: 1 J. (Sampling frequency: Pool 5; Riffle 5; Glide 5)
 (* Indicates information to be gathered at the Nth unit only)

FloodP.veg codes= GF,SS,SP,ST,LT,MT
Shrubland ht.=1(0-2') 2(2-5) 3(5-10) 4(>10')

A. State OR B. County 03 C. Forest 12 D. District 03 E. Stream Name: Example Creek
F. Watershed Code 17, 10, 02, 05 NFS 25 H. G. USGS Quad: Tide water
H. Survey Date: 42 / Aug / 25
Year / Month / Day

1. Reach Number: 2 J. (Sampling frequency: Pool 10; Riffle 10; Glide 10)
(* Indicates information to be gathered at the Nth unit only)
XX

[illegible]

FloodP.veg codes= GF,SS,SP,ST,LT,MT
Shrubland ht.=1(0-2') 2(2-5) 3(5-10) 4(>10')

Conifer Codes = CA, CC, CD, CE, CF, CH, CJ, CL, CM, CP, CQ, CR, CS, CT, CW, CY, CX
Hardwood Codes = HA, HB, HC, HD, HE, HL, HM, HO, HQ, HT, HV, HW, HX

Page: of

A. State _____ B. County _____ C. Forest _____ D. District _____ E. Stream Name: _____
F. Watershed Code _____, _____, _____ NFS _____, _____, _____, _____, _____ G. USGS Quad: _____
H. Survey Date: _____

I. Reach Number: _____ J. (Sampling frequency: Pool ____; Riffle ____; Glide ____)

(* Indicates information to be gathered at the Nth unit only)

FloodP.veg codes= GF,SS,SP,ST,LT,MT
Shrubland ht.=1(0-2') 2(2-5) 3(5-10) 4(>10')

Conifer Codes = CA, CC, CD, CE, CF, CH, CJ, CL, CM, CP, CQ, CR, CS, CT, CW, CY, CX
Hardwood Codes = HA, HB, HC, HD, HE, HL, HM, HO, HQ, HT, HV, HW, HX